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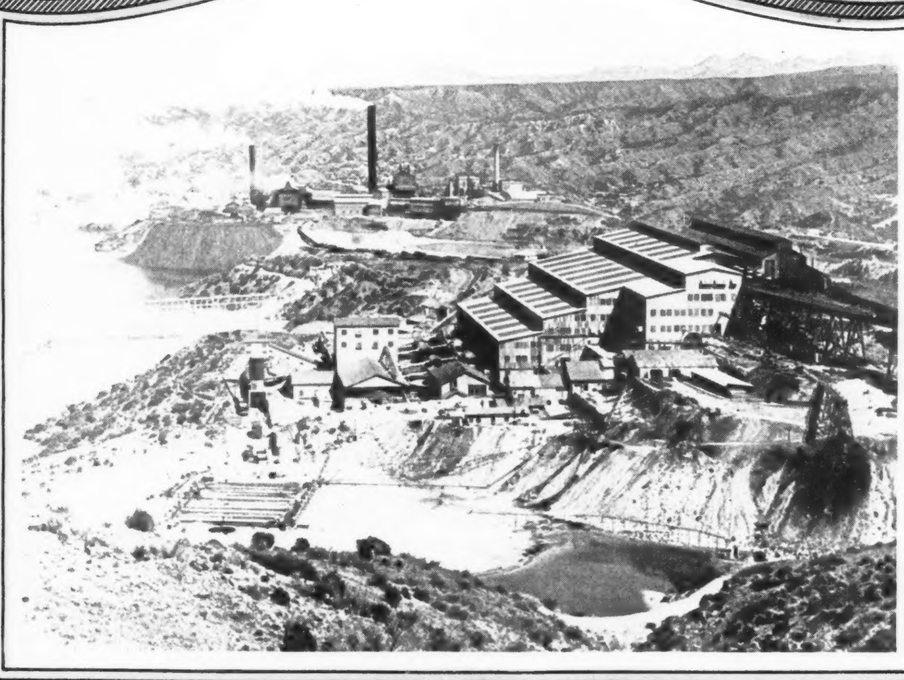
Compressed Air Magazine

Vol. XXVI, No. VI London New York Paris 35 Cents a Copy

JUNE, 1921



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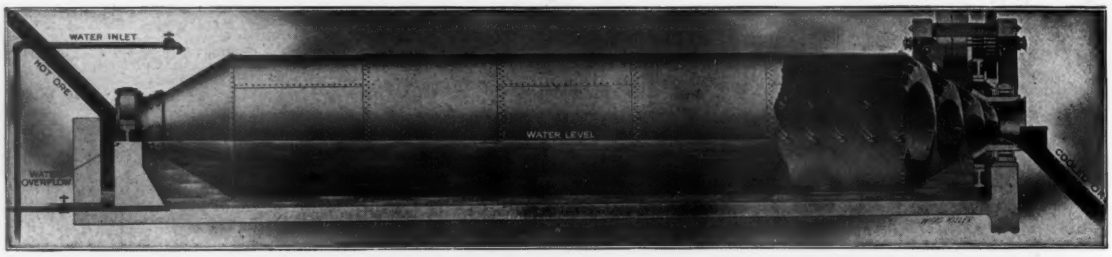

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The Potentialities of Liquid Oxygen Explosives

Liquid Oxygen Explosives Abroad Have Proved in Some Mines to Be Cheaper and More Effective than Dynamite. Further, this Novel Blasting Material Possesses Notable Claims to Superiority by Providing a Greater Degree of Safety

By ROBERT G. SKERRETT

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LIQUID OXYGEN may yet supplant dynamite to something more than an inconsiderable degree as a blasting material in mining and allied operations. Its claim to adoption rests upon lower cost and certain functional characteristics which make its employment somewhat less hazardous than the older and commonly used explosive. The likelihood of its substitution for dynamite and other permissible explosives is enhanced by the work done in the last few years by Dr. Georges Claude, of France, in perfecting apparatus for the fixation of atmospheric nitrogen and, still more recently, in devising mechanical means for the manufacture of synthetic ammonia.

This eminent French physicist has proved that it is entirely practicable to produce machines capable of compressing gaseous bodies to a pressure of 900 atmospheres and more, and to do this under circumstances that establish the commercial value of his epoch-making achievement. As a consequence, low-priced liquid oxygen in large quantities will be obtainable.

Ever since liquid air was produced in generous measure by that fertile-minded American, Charles E. Tripler, in the early "nineties," popular imagination has been gripped from time to time by the hope that that form of pent-up energy might be utilized for motive or propelling purposes. Every now and then someone has suggested that liquid air could be used in place of gunpowder, for the functioning of engines; and for other services calling for the development of power. But, somehow, very little progress was made in these directions. There were two outstanding obstacles: first, the making of liquid air on an industrial scale that would permit its sale at a moderate price; and then the difficulty of keeping it on hand until desired without inviting disaster or entailing a great and continual wastage the while.

Liquid air, as most of us know, tends to vaporize at atmospheric temperatures, and this process of dissipation must not be forcibly checked lest violent, shattering pressures be developed in the container. Finally, the "steaming" action can be checked only by putting the liquefied air in a double-walled vessel—a vacuum flask, in effect—that will insulate the intensely frigid fluid. One by one, ways and means have been evolved that render it possible to handle liquid air so that it will not evaporate as speedily as in the days gone; and thanks to the march of science it is feasible now to liquefy gases on a scale and at a cost unimagined when Tripler amazed the world about three decades back.

Profiting by what the Germans did with liquid oxygen as a blasting material, the U. S. Bureau of Mines investigated the subject at first hand shortly after the signing of the Armistice, and since then the Washington authorities have carried on research work at the Pittsburgh Experimental Station. While the substitution of this novel explosive for dynamite, etc., must be more or less slow, still much has been accomplished to this end; and even to-day we know that liquid oxygen is preferable especially in non-gaseous mines. By liquid oxygen we do not mean simply liquefied air, *per se*, but, instead, oxygen containing only a moderate percentage of nitrogen.

As a matter of historical interest, the Germans essayed to use liquid air—in which oxygen content was around 47 per cent.—along about 1897 in a coal mine in Upper Bavaria. The explosive was composed of pulverized charcoal saturated with liquid air, and this combination was insulated by a wrapping of sheep's wool. However, before the charge could be detonated, the heat of the enveloping rock induced rapid vaporizing of the liquid air, and owing to this the blasting force was slight. A year later *oxyliquit*, a German invention, was brought out, and different kinds

LIQUID OXYGEN, as an aid to industry, has won for itself substantial recognition by reason of the work performed by it during the World War. As we know now, the Germans made extensive use of liquid oxygen as an explosive, and in its employment discovered that this shattering medium had virtues that would warrant its adoption for certain services in time of peace.

As might be supposed, our own Government authorities were inspired to look into the subject abroad and to study here the adaptation of liquid-oxygen explosives to mining, quarrying, and constructional undertakings calling for the removal of masses of rock, old foundations, and other obstructions. The U. S. Bureau of Mines has made some important revelations in this field; and the accompanying article presents this data as an indication of what may be expected through a general adoption of the new explosive.

Once more the air compressor proves to be the primary source of a form of energy capable of meeting many needs and possessing distinctive merits.

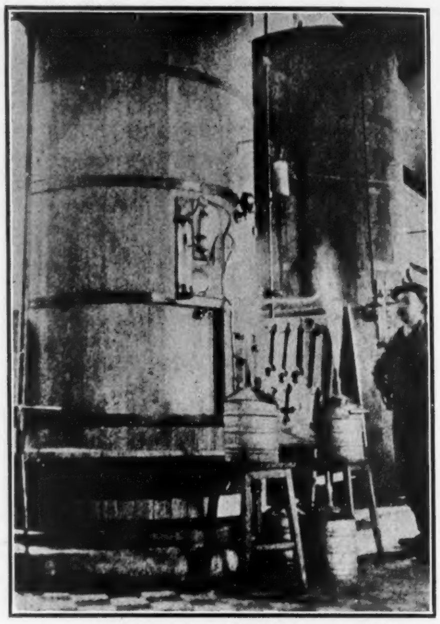
of charcoal were tested in search for the most suitable carbonaceous material as a "carrier" for the liquid air. Very promising results were obtained when petroleum, mixed with diatomaceous earth was tried. But the records show that no real progress was made until the Teutons awakened to the fact that their explosive was unsatisfactory unless the percentage of oxygen was high while that of nitrogen was kept as low as possible. The latter inert gas acts as a deterrent and slows up the combustion of the oxygen and the carbonaceous substance.

Oxyliquit had its first practical application in 1899, during the driving of the famous Simplon Tunnel. The explosive, then in its early form, was composed, apart from the liquid air, of soot, petroleum, and diatomaceous earth and it seems that its strength was substantially equal to that of blasting gelatin. While the results were reported to be decidedly promising, still the use of *oxyliquit* was halted after the death of Engineer Brandt, who was in charge of the experiments; and a number of years elapsed before further efforts were made to employ the compound. It is suggestive, however, that 58 grams of it developed the same pressure per square centimeter as 86 grams of gelatin dynamite or 283 grams of blasting powder. The combustion was complete, and carbon monoxide constituted but two per cent. of the gaseous products.

Not until after 1914, when Germany was faced with a shortage of glycerin and Chilean nitrates, were momentous steps taken to evolve practical methods for the adaptation of liquid oxygen for blasting purposes. Prior to that, however, Claude had done much to devise and to improve apparatus for the liquefying of air and other gases, while Carl von Linde, in Germany, was accomplishing noteworthy things on kindred lines. The Dewar flask, invented by Sir James Dewar in 1904, made it possible, by the aid of charcoal, to produce a high-vacuum in a double-walled vessel, and this could be counted upon to decrease greatly the rate of evaporation of liquefied gases stored in the chamber open to the air. Before the close of 1915, liquid oxygen as an explosive was doing its bit in three coal mines in Upper Silesia; and a trade journal at that time announced that blasting work could be done at a cost not in excess of that for dynamite—the price of the latter being put at approximately twelve cents per pound. When America entered the war the Germans had considerably extended the field of service of liquid oxygen explosives.

The U. S. Bureau of Mines began the study of liquid oxygen explosives in the Spring of 1917. The work embraced the trial of various carbonaceous materials mixed with liquid oxygen of different degrees of purity, the use of special cartridges, the design and construction of a soaking container of the vacuum-bottle type, and the testing of the explosives in standard apparatus and by blasting rock in quarries. The carbonaceous substances tried out included lamp black, wood pulp, and crude petroleum, which were combined in divers proportions. The stuff was then packed in cylindrical cheesecloth sacks, ranging from seven-eights of an inch to one inch in diameter, and the charge was set off by an electric detonator placed in the end of each sack.

To complete the explosive mixture, it is at present the practice to dip the sack into the liquid oxygen held in a large Dewar flask—the oxygen being decanted into the latter from the shipping container. In a few minutes the solid materials soak up the liquid oxygen, and the frozen sack is then withdrawn from the flask and inserted in a pasteboard tube, closed at one end, which has been chilled, in its turn, by dipping in the oxygen. A second tubular cover envelopes the cartridge, thus providing a double-walled container.



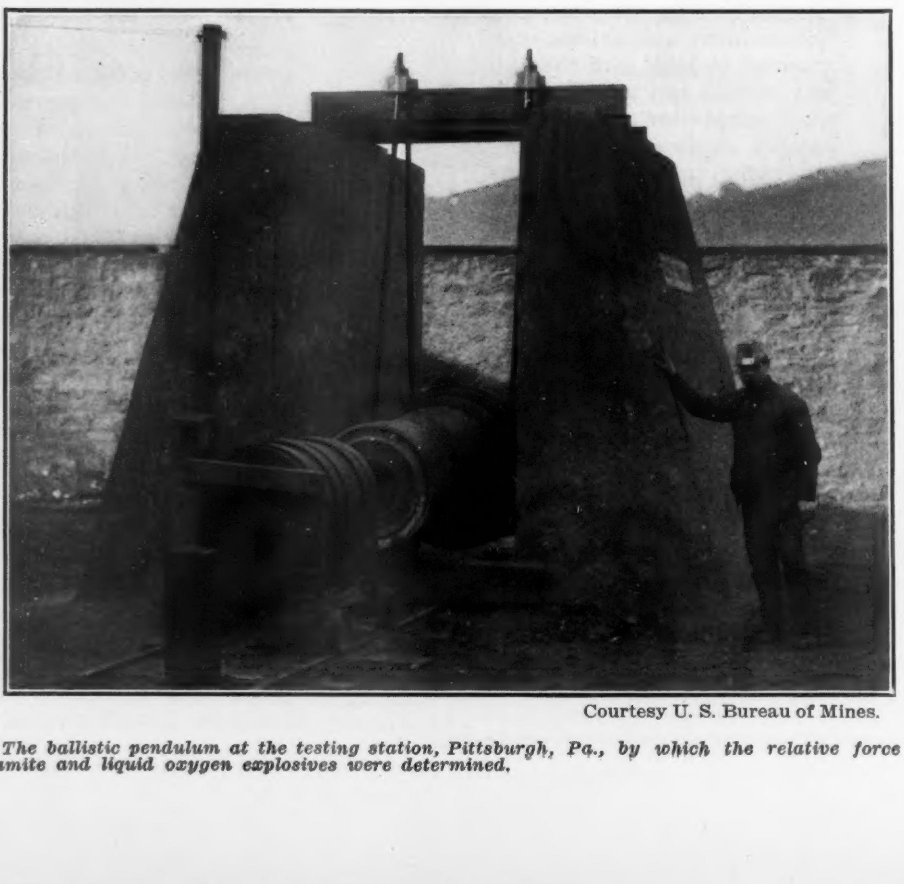
Courtesy U. S. Bureau of Mines.

Liquid oxygen plant at Moyeuvre iron mine. Observe discharge of vaporizing liquid-oxygen from vents of portable containers.

To get the right chemical balance between the amount of carbon and the quantity of liquid oxygen, it is needful that the pasteboard container and the cheesecloth be included in arriving at the weight of the carbonaceous material. This must be done in order to insure nearly complete combustion and, likewise, that the resultant fumes will be CO_2 and not noxious CO. To accomplish this, less carbonaceous matter by weight is required than oxygen; and this carbonaceous material must be a loosely compacted body, such as cotton or wood pulp. Otherwise, an inert absorptive substance should be mixed with the carbonaceous mass. The amount of carbon to be used is determined by the quantity of oxygen that a given volume will absorb. The explosive should contain enough oxygen to offset the amount that vaporizes before firing.

The impressive characteristic of liquid oxygen as a base for explosives is its passive nature until combined with a carbonaceous substance just prior to using it for blasting purposes. That is to say, if a proper vent be provided for vaporization, liquid oxygen can be transported and handled with a measure of immunity from hazard quite distinct from the risks run with dynamite, blasting powder, etc. Indeed, the detonator, itself, is harmless until soaked in liquid oxygen. Care must be exercised to keep the liquid-oxygen flasks remote from flame or sources of pronounced heat.

The miner or quarryman employing liquid oxygen virtually prepares his explosive on the spot by bringing together two otherwise fairly innocuous materials. But once he has effected this union it is needful to be as cautious as long experience has taught him to be



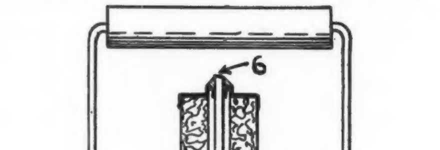
Courtesy U. S. Bureau of Mines.

The ballistic pendulum at the testing station, Pittsburgh, Pa., by which the relative force of dynamite and liquid oxygen explosives were determined.

in dealing with the explosives commonly utilized in his calling. There is a difference, however, which makes for safety in case of a misfire, i. e., the cartridge becomes virtually impotent after an interval of half an hour by reason of the evaporation of the oxygen. Further, if by any chance a cartridge falls into mine waste, coal, or ore and is buried, the subsequent removal of these materials does not involve any danger on that account.

This self-incapacitating of a liquid-oxygen explosive has its drawbacks, for it makes it imperative that the work of charging a hole be done rapidly. Even then, the miner must be sufficiently expert to place all his charges, connect the fuses or detonators, and reach a place of security within an interval of ten to fifteen minutes. How quickly the miner has to work can be grasped by the following details.

When the cartridge is ready it is put into the drill hole and a wad of cotton placed on it. A brass tube, three millimeters in internal diameter, is then inserted into the hole, and this should extend from the cartridge out to the face of the rock. Next, moist clay stemming is tamped into the drill hole around the pipe. With this done the brass tube is removed. The passage molded by the tube provides an outlet for the vaporizing oxygen until



Courtesy U. S. Bureau of Mines.

Container for the transportation of liquid oxygen into the mines.
1.—Evacuated space surrounding the liquid oxygen vessel.
2.—Attachment by which the initial vacuum is produced.
3.—Perforated plating.
4.—Granular charcoal.
5.—Insulating material.
6.—Vent for the escape of vaporizing liquid oxygen.

the shot is fired while the wad above the cartridge prevents the clay from stopping up the pipe during tamping. The escaping oxygen, if open lights are used, constitutes substantially the only danger likely to promote premature firing; but if there is no firedamp or coal dust present, this risk is no greater than charging any other high explosive into a drill hole, and is less than that when black blasting powder is used in the presence of open lights.

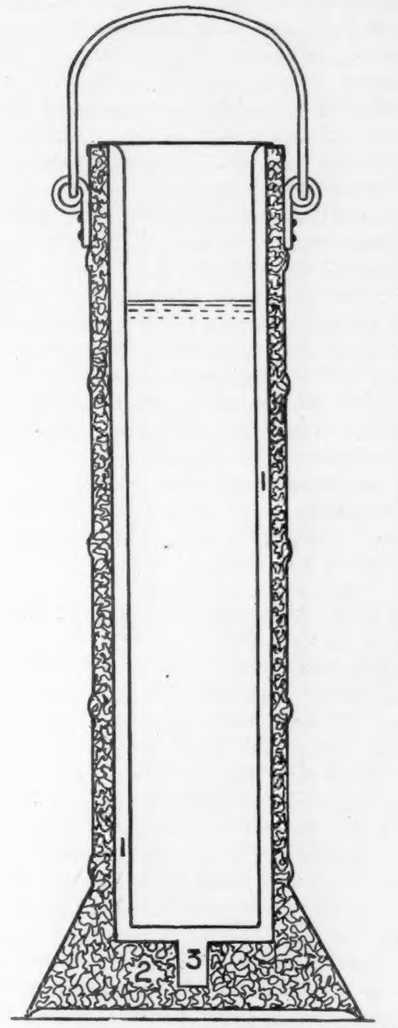
The experiments at Pittsburgh showed the strength of the liquid oxygen explosive, variously compounded, to be from four to twelve per cent. greater than that of 40 per cent. dynamite. Where the explosive was fired in an atmosphere containing four per cent. of methane and in the presence of coal dust, both the gas and the dust were ignited, thus disclosing that it would be hazardous to use the stuff for blasting purposes in gaseous coal mines.

Tests made to determine the rate of detonation of the explosive were illuminating. In one the rate was 3,031 meters per second, and in another this was found to be 2,996 meters per second. For permissible explosives the rate ranges from 1,447 to 4,439 meters. The duration of the flame of the liquid oxygen explosive was twenty times greater than that of the average permissible explosive, and the actual length of the flame, two and a half times longer. To offset this peril the Germans have resorted to various mediums calculated to make the explosive less menacing in the presence of firedamp.

According to experience both here and abroad, it is quite feasible to secure an explosive of either high or low shattering power by a careful choice of the filling materials and their proportions, thus regulating the absorptive capacity for liquid oxygen. When diatomaceous earth enters into the composition of the charge, it is absolutely necessary to use an ingredient of liquid hydrocarbon to stimulate combustion, because the diatomite is not a carbon carrier and plays the part only of a highly absorbent material for the storage of the liquid oxygen. Diatomaceous earth can take up twice its weight of the liquid explosive, and it is believed that the distinctive nature of this earthy matter fits it especially well for the transmission of impact or detonation. Charcoal, however, is an equally good absorbent and, is, besides, a perfect combustible, while diatomaceous earth is quite to the contrary.

At an iron mine in Lorraine, where the Germans, during the war, installed oxygen liquefying machinery so that the operatives could use a liquid oxygen explosive, the equipment was able to turn out 75 litres of liquid oxygen hourly. This product was between 95 and 98 per cent. pure, and was distributed to each pair of miners in a special container holding five litres of the fluid.

The cartridges were made of tough wrapping paper, wound in four thicknesses upon a tapered wooden former, split lengthwise so as to facilitate withdrawal; and the carbonaceous material consisted of fragments of wood somewhat coarser than ordinary sawdust. In this state, the wood tended to slow



Courtesy U. S. Bureau of Mines.

Dipping vessel used by the Germans in French mines.
1.—Evacuated space immediately surrounding the liquid oxygen carrier.
2.—Space filled with insulating material.
3.—Connection for vacuum pump.

up the explosive action. As was well-known to the Teutons, the finer the carbonaceous substance the faster the rate of detonation. The cartridges used at the mine were nine inches long and about an inch and a half in outside diameter. The French, following the German retreat, promptly adopted the liquid oxygen explosive, and had it in daily service when the place was visited by an American representative.

Mr. George S. Rice, who went abroad to study the European use of liquid oxygen explosives for the U. S. Bureau of Mines, has given some interesting particulars of what he found at Moyeuvre, Lorraine. The cartridges employed there are "active" for fifteen minutes from the time they are taken out of the dipping vessel. They are fired by a fuse and not a detonator. Before dipping, the cartridge weighs 100 grams, after saturation 300 grams. The dipping vessel holds four cartridges, and the carrying can, which has a capacity of five litres, is large enough to make up twelve or thirteen cartridges.

Five litres of liquid oxygen are sufficient for one mining chamber in which two men and one or two loaders are at work on an

eight-hour shift and provides for all the shots to be fired as well as evaporation loss. This loss is said to be but one per cent. of the original content per hour. The walls of the small dipping container are evacuated. In their case the evaporation is much higher, i. e., 150 grams per hour. The liquid oxygen outfit is located 30 or 40 yards from the heading.

A rotating auger hammer drill, driven by compressed air, was used in this mine to bore the necessary holes in the ore. The practice is to drill one or two holes and then to charge and fire them. One outstanding feature was that the liquid oxygen explosive seemed to yield so inappreciable an amount of carbon monoxide, or other harmful gases, that the miners could return to the face immediately after the shot. The smoke caused no discomfort. The loading and firing stages were as follows:

Operations began, in one instance, at 10:12 a. m. by loading the hole. Three minutes later the miner was ready to ignite the fuse from his open light. At 10:17½ a. m. the shot was fired. At another heading a cartridge was put in the drill hole at 10:49 a. m.; at 10:51 the fuse was lighted; and at 10.52½ the blast took place. The shot did good work every time—throwing down about two tons of ore.

The cost of the liquid oxygen at this mine was given at 25 cents (pre war value) a litre. Together with cartridge material and fuse the price per litre of oxygen came to 29 cents. This amounts to practically fourteen cents a pound for the complete explosive. If the plant at Moyeuvre could be kept going continually, the outlay for the oxygen, so it is claimed, could be cut down to ten or twelve cents a litre and that for the explosives to fourteen or sixteen cents per litre. The liquid

Courtesy U. S. Bureau of Mines.

The essential parts of a liquid-oxygen cartridge. From right to left, inner insulating paper or pasteboard shell; cheesecloth bag filled with carbonaceous material; and outer insulating pasteboard or paper shell. The fuse passes out of the smaller shell to the right. This may also be the connection for an electric detonator.

Courtesy U. S. Bureau of Mines.

"Simonis" liquid-oxygen container used extensively by the Germans while operating coal and other mines during the war.

oxygen was stored in a large tank in the liquefying plant and it was said that the daily loss through evaporation was negligible.

At the Auboué iron mine, in the Briey district, the Germans established a plant for the manufacture of liquid oxygen explosive. They used this blasting medium variously in certain coal mines which were non-gaseous, in tunnel work, in the excavation of subways, etc.; and the Teutons also employed the same kind of explosive when destroying the great French steel mills at Longwy. From a confidential military paper entitled: *Instructions for Blasting with Liquid Air—Staff of the First Royal Prussian Pioneer School*, it is evident that the Germans found liquid oxygen a very adaptable base for blasting charges; and the opening paragraph of this communication contained the following significant disclosure: "Liquid air can be used with advantage in the construction of communication tunnels and dugouts, the driving of mine galleries, the rapid construction of shelter and communication trenches, etc., and for the destruction of all classes of obstacles."

In withdrawing the saturated cartridges from the soaking vessel wooden tongs have been commonly used, and the Germans warn against the wearing of gloves when working with liquid air, as the glove material is apt to absorb the intensely cold fluid and hold it that much longer in contact with the skin. A German technicist, H. Diedrichs, has stated that liquid oxygen, despite its low temperature of 301 degrees Fahrenheit, below zero, does not "burn" the human skin on touching it lightly, and therefore it would seem that there is small danger of a worker's hands being hurt if the frigid liquid is accidentally spilled on them.

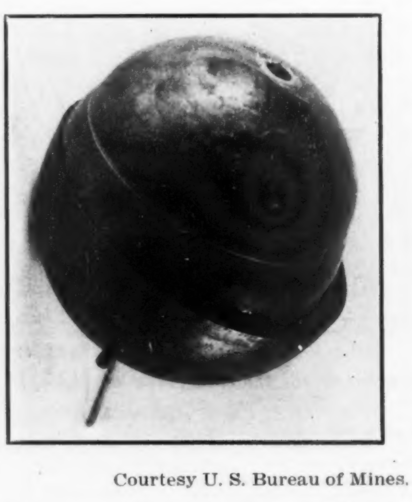
According to the experience of the German army in using liquid air as an explosive during the war, it appears that fewer bore holes are required in the case of this blasting medium than with ordinary explosives. To insure success, however, it is necessary that the bore hole be straight and of uniform diameter, and the latter should be about two millimeters greater than that of the cartridge. It is also essential that the hole be free from dirt so that there shall be no likelihood of tearing the cartridge when being pushed into the recess.

Abroad, efforts have been made to prolong the effective life of the cartridge so that more leeway may be given the miners in charging a number of holes and then reaching a place of safety before the firing of the blast. This has led to two methods of rendering the cartridge explosive. In one, the cartridge is shoved into position in the bore hole, after which it is impregnated with the liquid oxygen—the latter being forcibly injected from a handy container which, when turned upside down, makes use of the pressure of the overlying gasified oxygen to cause the expulsion of the liquid.

This procedure has serious drawbacks, especially where either a single long cartridge of small diameter or a number of them of shorter length are demanded in filling a hole. The difficulty lies in thoroughly soaking the carbonaceous mass with liquid oxygen; and if this be not accomplished the excess carbon will be blown out by the blast while burning, and generate poisonous CO.

The other method depends upon the precooling of the carbon carrier to make it more capable of absorbing the liquid oxygen. To this end, the carbonaceous material, prior to dipping the cartridge, is exposed to the frigid gases continually escaping from the soaking vessel—thus utilizing a refrigerant that would otherwise have to be counted a loss. This technique is based upon the same principle employed by Dewar in his vacuum flask, i. e., the greatly increased absorptive capacity of carbon when cold. Half an ounce of charcoal, chilled to the temperature of liquid air, will soak up enough air to fill a three-quart bottle! It would seem that by precooling the paper or cardboard cartridge shell, as practiced by the U. S. Bureau of Mines, the effects of the heat of the surrounding rock are so minimized as to materially prolong the full blasting force of the charge.

Coming down to costs and using the figures



Courtesy U. S. Bureau of Mines.

Partly dismantled "Simonis" liquid-oxygen container.

furnished by Diedrichs late in 1915, one pound of dynamite produced 4.5 metric tons of coal, while a pound of liquid oxygen explosive yielded 6.8 metric tons of coal—a metric ton being of 2205 pounds. The price of a pound of dynamite was then sixteen cents and that of an equal weight of liquid oxygen explosive was fourteen cents. Therefore, a metric ton of coal required the expenditure of three and one-half cents' worth of dynamite or two and one-tenth cents' worth of the liquid oxygen explosive. A German company engaged in the manufacture of *oxyliquit* is reported to have turned out annually for a number of years the equivalent of 10,000 tons of nitric explosives thus freeing that measure of the usual explosives for military purposes.

From the information available, it is apparent that the Teutons have taken the lead in developing liquefying units suited to the industrial requirements of undertakings employing the new explosive; and one of our tasks is to evolve small liquid oxygen producing plants that can be installed at moderate expense at mines, quarries, etc. The recent accomplishments of Dr. Georges Claude would seem to point to an economical solution of this problem. Surely we should not find it difficult to put our engineering practices in this particular field on a par with those of Europe, in view of what we have done in bringing air compressors to their present state of high efficiency and in applying compressed air with pronounced success in numerous directions.

Apart from liquid oxygen, the other ingredients of this novel explosive can be had for a song, and in plenty. Abroad they have used powdered cork, soot, sawdust, pulverized straw, and various other carbonaceous substances. The objection to soot is that it is apt to generate very troublesome if not dangerous quantities of carbon monoxide after the detonation of a cartridge so charged. Interesting as this whole subject is, still we must recognize that both the manufacture and the employment of liquid oxygen as a blasting medium are in a state of flux, and that we may reasonably count upon our own people to do much in effecting improvements in the near future.

Mr. Rice is convinced that liquid oxygen explosives are of much value, and that their use would tend to lower the costs of blasting in coal mines which are free from firedamp and dangerous dust; in non-gaseous anthracite mines; in iron, salt, and other mineral mines where the chamber method of mining is practiced and where only a few shots at a time are fired; and in quarries where a small number of heavy charges could be set off simultaneously.

As has been emphasized, the cost of the liquid oxygen is the chief outlay in the new explosive. Therefore, any marked betterment in liquefying machines will inevitably reduce the price of the essential ingredient in proportion to the increased productiveness. Inasmuch as the expense of standard explosives has been steadily mounting for some years, the adoption of liquid oxygen explosives, wherever practicable, will lead to a substantial saving. This fact, in all likelihood, will lessen and overcome the opposition of miners and quarrymen who would naturally be inclined to persist in employing the older and familiar blasting agencies.

KINK TO PREVENT PLUGGED STEEL IN TALC SEAMS

ONE OF THE mines in the Coeur d' Alene district encounters in some places underground, soft talc seams which are frequently of considerable width. When these slips are struck the drill steel will become plugged after a very few inches of drilling and the sludge will be forced through the hole in the hollow drill steel closing it at times from end to end.

On either side of these seams the rock is hard. The operator can tell the instant he strikes the soft material from the feel of the machine.

A simple, yet novel method has been adopted to prevent this plugging of the drill steel. The operator stops his machine when he strikes a soft slip, he removes the steel and drives a wooden plug ⅜ inches in diameter by ¾ inches long in the hole in the bit. He uses the steel until he strikes hard rock again or if the steel runs out, he puts a wooden plug in the following steel. Then he removes the steel with a wooden plug and continues drilling with a standard steel.

This scheme works splendidly. It saves a lot of time in the sharpener shop cleaning out plugged steels and enables the underground man to increase his drilling.

The wooden plugs are made by cutting wood ¾ in. thick and punching out the plugs with a ⅜ in. belt punch, punching with the grain of the wood.

One man can make a thousand of these plugs in a day. The miners carry a supply in their pockets as they are light and small and they use them because it saves a lot of work on their part.

When the bits are to be resharpened, the plug burns out and the steel is clear of mud.

SPONTANEOUS IGNITION OF AIR AND ETHER VAPOR

E. Allaire, writing in *Comptes Rendus*, has studied the conditions governing the ignition of air and ether vapor, using a special apparatus by means of which the proportions of the two gases could be varied as desired. The apparatus consisted of a force pump driving air into a gas meter, the measured volume of air passing on into a tube in which it was mixed with ether vapor, obtained by the volatilization of ether from a tube surrounded by wire electrically heated. The pure ether was measured with a burette. Thus the proportion of ether at 0° and 760 mm. could easily be calculated if the temperature and pressure were known. The gaseous mixture was led into a U-tube, one limb of which was furnished with points like a Vigreux tube and having an opening through which a thermometer could be introduced into the bend. The whole tube was immersed in an oil-bath. Various catalysts, such as oxides of iron, copper, nickel, etc., were tried, but it was found that they had apparently no influence on the phenomenon, and the mixture ignited spontaneously at about 190°, when the amount of ether present was about 1 grm. per litre. The flame was pale blue, and visible only in the dark, and the products were ethyl and methyl aldehydes and carbonic and acetic acids. No reaction took place before ignition occurred. A knowledge of this phenomenon explains the occurrence of accidents in factories and work-shops in which ether vapor may spread accidentally in large quantities. It might be possible, by modifying the conditions of the experiment and by using tubes of greater diameter to bring about ignition at lower temperatures.

It is much to be regretted that the reported investigation dealt only with ether vapor. We are still in need of information as to the point of spontaneous ignition of mixtures of oil vapor and air such as doubtless occurs in some air compressor explosions.

DYNAMITE DIGS DITCH IN RECORD TIME

A drainage ditch, 2,000 feet long, three and one-half to four feet deep, and seven to eight feet wide, according to *Popular Mechanics*, was blasted with dynamite through a pasture near Millen, Ga., recently. Half-pound charges of the explosive were planted at one foot intervals, and fired in relays of 400 to 500 at a time. So perfectly was the work performed that drainage water began to fill the big ditch as soon as it was completed, and flowed away into a connecting stream. Over 2,000 cubic yards of earth were displaced in a few moments after the blasting signal was given.

LIQUID OXYGEN IS HANDLED SAFELY IN CONTAINER

The increasing use of liquid oxygen in life saving respiratory apparatus, airplanes, and as a mine explosive, has made necessary the development of a container for it of a stronger, more reliable construction than the vacuum-walled glass bulbs used heretofore says *Popular Mechanics*. To meet this demand, the Bureau of Standards has designed a durable vessel without vacuum walls, the contents being protected from heat by a coating of insulating material with which the device is covered. Another improvement is a valve mechanism which liberates the gas at a constant rate.

France's quick recovery from the devastations of war is shown by the progress made in rebuilding the railroad line that was entirely destroyed. She has completely restored 1,490 miles of double track, and 1,122 miles of the 1,727 miles of single track.

A delegation of five Frenchmen, representing the Paris-Orleans Railroad, France, are in this country for the purpose of inspecting the Westinghouse air brakes that are used in some locomotives. They have already visited the Pittsburgh district and are very much impressed with the use of air brakes, as the French cars are devoid of these, the vacuum system being used.

MOST DESTRUCTIVE DUST EXPLOSION ON RECORD

The Northwestern Terminal Elevator, 122nd St. and Torrence Avenue, Chicago, said to be the largest and most modern and complete in the world, has been totally destroyed by a dust explosion. It is difficult to conceive the completeness of the catastrophe. The following we abstract from the report of J. C. Marshall, Chief of the Bureau of Fire Prevention and Public Safety of Chicago.

The elevator had a capacity of 10,000,000 bushels. It was 550 feet in length, east to west, and 312 feet, north to south. The bin portion contained 182 tanks, each 110 ft. high To the east of these 182 tanks, was a receiving and shipping structure 191 feet in height containing 24 tanks, with a marine tower at the south end of the receiving and shipping department. This marine tower was about 40 feet square and 144 feet high. The receiving and shipping portion is connected with the 182 bins both at the top and the bottom by conveyor belts. To the west of the 182 tanks was a 191-foot high structure which contained 95 grain tanks. Above these tanks were the cleaning floor, clippers, bin floor, scale floor and garner floor. The elevator had 38 legs, 16 cleaners, and two separators on the bin floor. The entire structure was absolutely fireproof, of concrete and steel throughout.

It is impossible to adequately describe the extent and character of the destruction. It is believed that none of the war explosives could have been so distributed through the plant as to cause a result so complete.

Concrete slabs from ten to fifteen feet in diameter and from eight to ten inches in thickness were hurled 400 feet and buried themselves five feet in the ground. A platform fire escape having nothing but iron bars for the platform was hurled 300 feet and stuck in the wall of a dust-collecting building. The 140 foot marine tower was shifted 40 feet from the bank of the river and deposited in the river. Many empty tanks were practically annihilated. The foundations of the tanks consisting of 30 inches by eight foot reinforced concrete abutments were shifted, in some cases, six inches and in some cases three feet.

Dust explosion in Chicago which tore sections of the greatest grain elevator in the world into fragments. Glass was thrown over an area of five miles.

Immediately north of the elevator and separated about 50 feet were three 2-story reinforced absolutely fireproof concrete buildings, used respectively as office buildings, boiler room and power house. These buildings were totally destroyed, the concrete roof and the concrete second floor being carried to the ground floor. Nothing but the bare brick walls remain. A large brick chimney 211 feet in height immediately adjoining this power house had a large triangular piece of brick work dropped out of it right at the rim. This is phenomenal, when the missing brick was on the opposite side of the chimney from the elevator itself, showing that nothing other than air pressure could have sucked the brick out.

Six persons were killed. Two bodies were in the wreck. The ruins present a very difficult proposition in the effort to clean up, because of the fact that there is nothing on the premises except concrete and twisted steel "H" columns. The elevator was in a very isolated location. The amount of fire was very small, because of the fact that there was no combustible material about other than the grain dust. That only six persons died means there were only six persons on the premises at the time of the explosion.

All that was left of the world's largest grain elevator at Chicago after a dust explosion that caused a property loss totaling six to ten million dollars.

BLASTING DOWN TREES

Splinters seldom fly from standing timber, so it is best to blast down the tree and blast out the stump at the same operation. A successful example of this was afforded by the removal of nine pine trees, averaging fifteen inches in diameter, at Rosemary, N. C. Bore holes were put in on opposite sides of each tree and in each hole there was placed a pound of 40 per cent. ammonia dynamite and both charges were fired simultaneously with electric caps and a blasting machine. Ropes tied to the trees about 20 feet above the ground determined the direction of fall, and the trees were brought down, removed from the site and the ground ready for plowing in ten hours at a cost of $16.

The Engineering Business Exchange announces the opening of a Southeastern Branch with Mr. Marshall O. Leighton, Consulting Engineer, of Washington, D. C., as Director Mr. Leighton graduated in 1896 from the Massachusetts Institute of Technology. He is a member of the American Society of Civil Engineers and the Cosmos and Chevy Chase Clubs in Washington.

Associated with Mr. Leighton in carrying on the Exchange will be Mr. A. C. Oliphant, who was also active in the work of the Engineering Council's National Service Committee.

PORTABLE AIR COMPRESSORS IN COAL MINES*

By F. H. WAGNER†

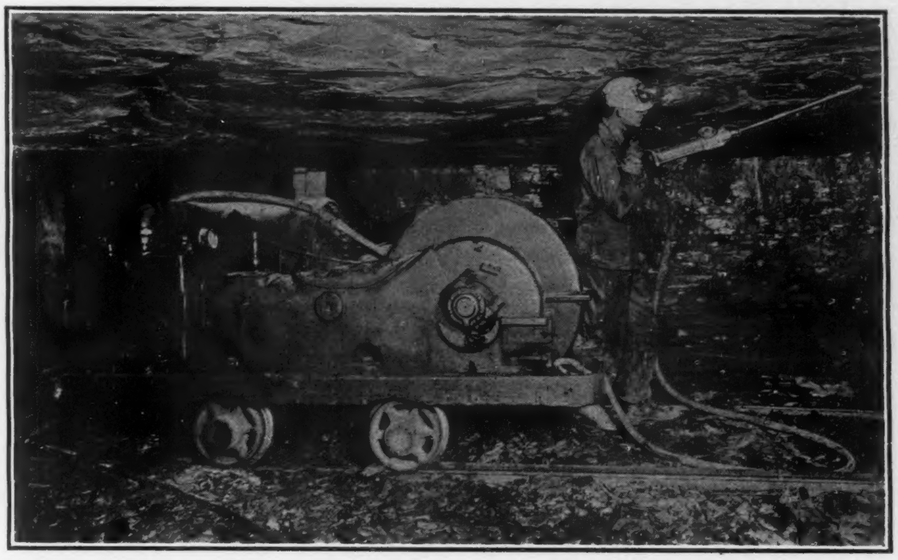
THE MINING of thick veins such as the Mammoth and Buck Mountain veins of the lower anthracite fields has been successfully carried on by the driving of rock gangways and connecting rockholes from these gangways to the aforementioned thick veins. From the viewpoint of economy and efficiency, a heavily timbered gangway, subject to squeezing in robbing or pillar mining, is eliminated and a more complete recovery of the coal left in pillars is obtainable. Coal lying in pillars below the point of tapping in thick veins is recoverable by a similar rockhole method employed on a lower level.

In veins having a thickness of two feet or less, it is necessary to lift more or less bottom rock or blow top rock as the case may be, hence the term rock gangway is applied to gangways of this type. From these gangways at comparatively regular intervals, rockholes are driven from which pillar chutes are driven up and characteristic robbing of the Mammoth and Buck Mountain veins is carried on. I have found that alternating the driving of these holes has avoided the starting of any squeezes that might have serious consequences in overlapping pillars remaining unmined. Our object for each successive rockhole has been to break the roof if possible; hence the pillars outside or inside that particular area are unaffected. The gangways, as well as airways and chutes, are driven in these thin veins and as comparatively little timber is necessary in these gangways, their maintenance cost is very low and they are of a permanent nature.

The driving of these gangways by hand was very slow work, and in order to obtain greater speed, compressed air and jackhamers were introduced. Durnig the World War and for a long period following, considerable difficulty was experienced in obtaining hand rockmen. Material also was slow in delivery as well as excessive in cost. To drive these rock gangways and rockholes, the question arose as to the advisability of using portable air compressors, or a permanent compressor plant centrally located and the mines piped therefrom.

Taking Packer Nos. 2, 3 and 4 Collieries as an example, the workings of these operations all having direct inside connections, the material cost of the installation and operation of a permanent plant would be $18,500. As these mines are wet, the corrosive and chemical action of the highly acid mine water on 14,300 feet of main airline wrought steel pipe was taken into consideration. A section of six-inch wrought steel pipe, in direct contact with the mine water, became useless in a trifle over three weeks, hence long air lines exposed to mine water were not deemed advisable. The application of non-corrosive paint to the surface of these air lines was considered, but this in itself naturally added to a high cost figure.

*Reprinted from "Employees Magazine" of the Lehigh Valley Coal Co.
†Division Superintendent, Lehigh Valley Coal Co.



Ingersoll-Rand Class "ER-1" mine car compressor and "Jackhamer" outfit working in the Lynch, Ky., mines of the U. S. Coal & Coke Co.

Air lines carried along a main haulage line and tunnel are open to accidents such as derailments, roof falls, leaky joints, blowouts along seams, etc.

The big advantage or argument advanced in favor of piping the mines is the utilization of the pipe in case of mine fires. It has been my experience to have gone through a number of mine fires and although some of these fires occurred in mines having a central plant, the pipe lines, unfortunately, lay in a new section of the workings where the development and rock work were carried on, while the fires raged in old sections in which no pipe lines were available for speedy connection to a pump. Therefore, in lieu of a central compressed air plant, we decided on portable compressors. The mining and development warranted the purchase of five compressors, the initial cost complete (air hammers and hose included) being $14,550.00.

These compressors were placed at convenient locations either along a widened portion of a gangway free from the gangway track or at a gangway and tunnel junction, allowing short lengths of pipe lines to be used. The size of pipe used in general is one and one-half inches on the ten-inch by ten-inch compressors and one-inch on the nine-inch by eight-inch compressors. In my opinion, the ten-inch by ten-inch compressors give more favorable results than the nine-inch by eight-inch, as the former permits of four jackhamers in use at one time with fair results. Using three hammers from the air line running to 600 feet in length, excellent hole speed is obtainable. With nine-inch by eight-inch compressors, only two hammers may be used successfully.

The upkeep cost on the five compressors for one year amounted to $480.00, all five being used and seeing hard service. The upkeep cost on a centrally located plant in the same division amounted to $640.00. The life

9x8 Ingersoll-Rand Class "ER-1" mine car compressor in the mine of the Pennsylvania Coal Co., Avoca, Pa.

of short length pipe lines was eighteen months on the average. The main air lines from a centrally located plant were changed practically three times in certain sections in the same period of time. On the two and one-half-line, the upkeep cost in eighteen months was about $460.00 against $100.00 for lines on the portable compressors.

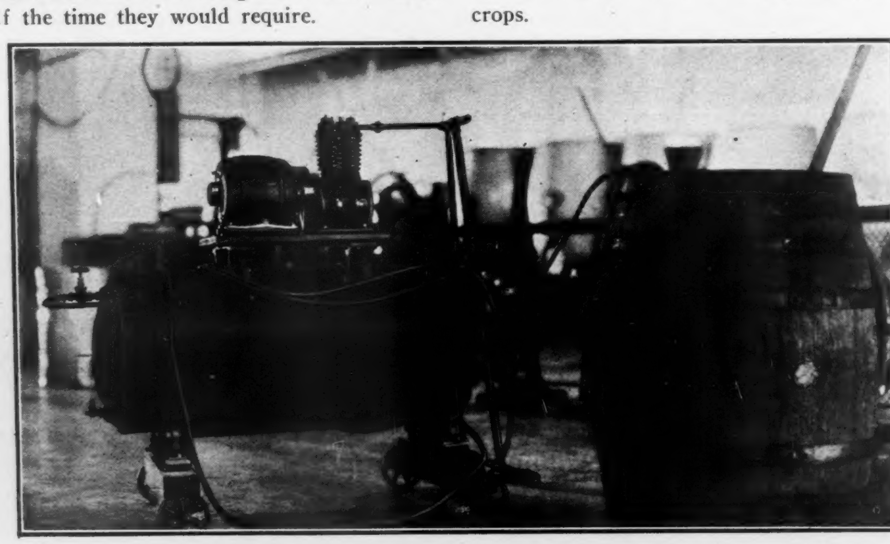
The portable compressors are as easy to handle as a mine car and have been utilized in different sections of the mine on the completion of the drilling work on one shift. One disadvantage encountered in these compressors as received from the manufacturer was the shortness of wheel base and, on one make, the end overhanging of compressor and electric driving units. This was overcome by rebuilding the compressors on a regular car-bottom with the standard wheel base of the colliery.

The attendant care necessary for these compressors has been comparatively small, the colliery electrician looking after the electrical units and a machinist after the mechanical or compressor end. Constant attendance is not required, but like all other machinery, a reasonable amount of attention is required. They do not, however, demand the attention of a single operator as does a centrally operated air plant.

The use of portable compressors naturally does not confine itself to rock gangway and rockholes but on rock work of any nature as well as particularly hard seams of coal.

LIQUIDS MIXED BY COMPRESSED AIR

A GREAT IMPROVEMENT has been made in mixing liquids by the Owl Drug Company at San Francisco. Formerly this mixing was done by hand, now it is done by compressed air. A portable air compressor is used, so that it can be moved near the barrel containing the liquid to be mixed. A hose is extended into the barrel of liquid, a weight being attached to the end of the hose that is inserted in the barrel, to keep it from flopping out of the barrel. In this manner, the air pump sends filtered air into the liquid, thus acting as a mixer and taking the place of at least two men and doing the work in about half the time they would require.



Mixing liquids by compressed air.

ELECTRICITY TO STIMULATE PLANT GROWTH

A REPORT, recently published, of the Development Commissions (British) notes the success of certain experiments in electroculture, carried out in 1918. The effects of high pressure electrical discharges upon the growth of crops were tested in the following manner: Wires were stretched above the crop and charged to a potential of about 50,000 volts, with the result that a small current passed through the air to the crop below. The most striking point about the majority of earlier experiments of this nature is the neglect of measurements of the current used, and on this account one electro-culture experiment could not be compared with another, and there was no certainty whether too much or too little discharge had been allowed to take place. To test the action of the current and to fill this serious gap there were started a series of plot experiments in different parts of the country, a series of pot experiments, and also laboratory experiments with single seedlings. In all these experiments careful measurements were made of the current supplied, and special experiments were directed to the determination of the maximum and minimum current which could be used. The plot and pot experiments have now been continued for a number of years, and converging evidence from the field and from the laboratory indicates very clearly that by such treatment the growth of a cereal crop can be markedly increased. Differences as high as 50 per cent., 38 per cent., and 35 per cent. in favor of the electrified areas have been observed in a number of cases. It has further been shown that the plants are sensitive to a very small current, so it is easy to give a discharge which reduces, instead of increasing growth. The amount of electric energy supplied to the individual plant is exceedingly small, for the total energy supplied *per acre* is only as much as that required for a 50 candle-power lamp. If the cost of the installation required to produce and distribute electricity in actual agricultural practice can be kept low, a new method is available for increasing the yield of crops.

IMPORTANT CONTRIBUTION TO AIR LIFT LITERATURE

A PAMPHLET entitled *The Air Lift System* is a valuable and to date, the most comprehensive treatise issued by any manufacturer describing this form of mechanical equipment. It is published by the Ingersoll-Rand Co. and describes the art of pumping water, other fluids, and semi-fluids by compressed air. The range of usefulness of the air lift, we are told, covers municipal, manufacturing, irrigation and other water supplies and is adapted for operating in mines, metallurgical processes, and for lifting solids mixed with water.

A significant statement is made in a general discussion of the air lift which tells us that, "It is not necessary to make any mystery of the operation of the air lift, and no one has any privilege to pose as an exclusive repository of special information concerning it, although in the practical application of it, it is quite true that experience counts for much and is more absolutely necessary than in any other field."

RESULTS FROM CHANGING A SHIP'S PROPELLER

A very interesting alteration has recently been successfully carried out on a cargo vessel at the Barcelona shipyard of the Astilleros del Mediterraneo, now under the management of John I. Thornycroft & Co., Limited. Before Thornycroft's took over the management, the SS. *Olesa* of 1,000 tons dead weight had been completed, but had failed to obtain the designed speed. It was considered that the fault was due to the propeller, and they decided to increase the diameter from five feet seven inches to nine feet eight inches, the pitch from seven feet two and three-fourths inches to seven feet ten and one-half inches, and the surface from 16.7 square feet to 29.3 square feet. To effect this it was necessary to cut away the original sternpost and scarf a new piece in position, a very difficult operation, as the finished job, after riveting up, required to be machine fitted, and exactly to the gage of the old sternpost, to allow of the lower rudder pintle working freely. The vessel was dry-docked and the whole operation completed within a fortnight to the entire satisfaction of the owners and the approval of Bureau Veritas Surveyor. The improvement effected by the change was quite remarkable, the speed being increased from five and two-tenths knots to eight and six-tenths knots, and at the same time the vibration, which had been exceedingly bad with the small propeller, entirely disappeared. The effect on the voyage from Barcelona to Bilbao is that the steaming days are reduced from eleven to six and seven-tenths, and the saving in coal for the round voyage is 40.2 tons, the equivalent cash saving being 8,040 pesetas. The above results are interesting as showing what an important influence the propeller has upon the economical working of a vessel. It is not often the case that in a merchant ship a change of propeller can effect an increase of nearly three and one-half knots in the speed.

The Uses of Compressed Air in the Modern Battleship

The Destructive Power of the Great Capital Ships—the Dreadnought and the Battle Cruiser are Dependent upon a Readily Available Supply of Compressed Air

By CAPTAIN YATES STIRLING, JR., U. S. NAVY

THE PRESENT day capital ship is a veritable epitome of all engineering advance and a reflex of much of scientific progress. She is, in truth, a navigable fortress, a floating town, and must carry every up-to-date agency that will render her equal to the manifold demands which service in peace and war requires.

Her power to strike with disastrous might, her capacity to withstand retaliatory blows, her facility in meeting many contingencies, and, finally, her fitness as a healthful, happy home for her complement of a thousand and more are largely contingent upon an ever-ready supply of compressed air.

Year by year, the designers of these battle craft and the men that operate them find added ways in which this flexible form of energy can be utilized to advantage.

Compressed air impels the torpedoes from the tubes, operates the pneumatic tools for making repairs, atomizes the liquid fuel in the galleys, is essential for the refrigerating equipment, and performs numerous other services, increasing the efficiency of the modern battleship.

AT THIS very moment the experts of at least three great nations are trying to decide what is to be the capital ship of the future. Is it to be the great dreadnought costing upwards of fifty millions of dollars which the weight of opinion seems to favor, or is it to be some form of glorified submarine so consistently advocated by Sir Percy Scott, or on the other hand is it to be the great air battle cruiser strenuously espoused by General Mitchell?

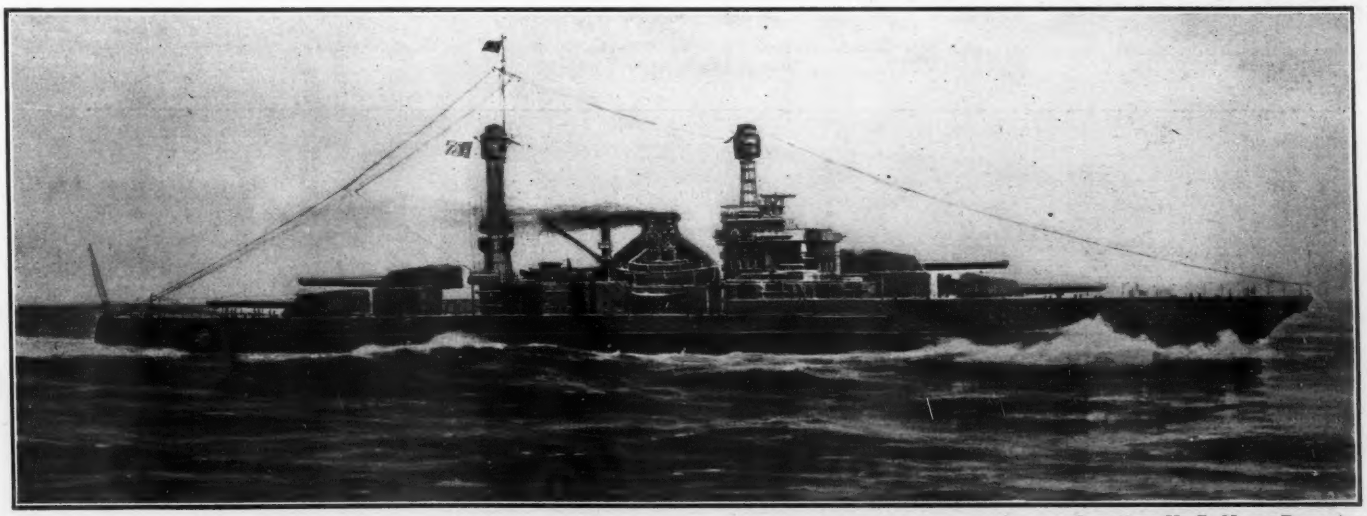
The submarine and the airship insinuate themselves upon our favor by reason of their moderate cost. A large submarine cruiser, say of 3,000 tons displacement, such as Germany had on the stocks when the war ended, would not cost more than five million dollars and would carry enough destructive power to send to the bottom of the sea one battleship for each million dollars spent. Two hundred and fifty million dollars worth of destruction for the expenditure of five million is a wonderful dream to want to make true.

General Mitchell is certain that one large bomb of high explosive dropped upon the deck of a modern dreadnought, would, if not destroy it outright, render it useless for further fighting by disrupting all electrical connections and by giving the entire crew shell shock. One battle cruiser of the air larger than the N.C. type, that successfully crossed the Atlantic, would not cost more than five hundred thousand dollars, and would if General Mitchell has guessed rightly, be able to destroy one battleship for each bomb carried. This of course presupposes perfect markmanship on the part of the airship. These are, in truth, fascinating dreams and their realization would take the luxury of war into every home, as it were. The great and rich nations would no longer have their monopoly, for even the smallest could afford a handful of submarines and a moderate size flock of airships.

There is one point worth remembering while dreaming of these marvelous possibilities. That is the object of fighting on the sea. Two nations adjoining each other by land and having no interest on the sea would not be likely to have a navy at all, and in the event of war would do all their fighting on the ground and in the air. Sea power embodies the coördinated efforts of the sea and air forces of a nation, in peace to preserve its commerce, and in war to destroy its enemies' commerce. The bulk of the world's commerce will be carried by surface vessels for many years to come. We have ample proof that commerce can be destroyed very effectively by submarines. Have we proof that it can be protected with submarines?

While the German submarine was sweeping the merchant marine of England off the seas, was that nation able to use the surface of the sea for either its warships or its merchant ships? What was the reason that Germany was starved into submission to the will of the Allies, and with upwards of several hundred of the most marvelous submarines the world has ever seen? With these splendid vessels, this destruction could have gone on almost indefinitely, provided, Germany at the same time could have found means to protect its own sea borne commerce and thus continued its economic life. The submarine was not adequate to the double task. It is self evident that the air ship cannot protect commerce, though in the next war it may become a useful weapon for destruction.

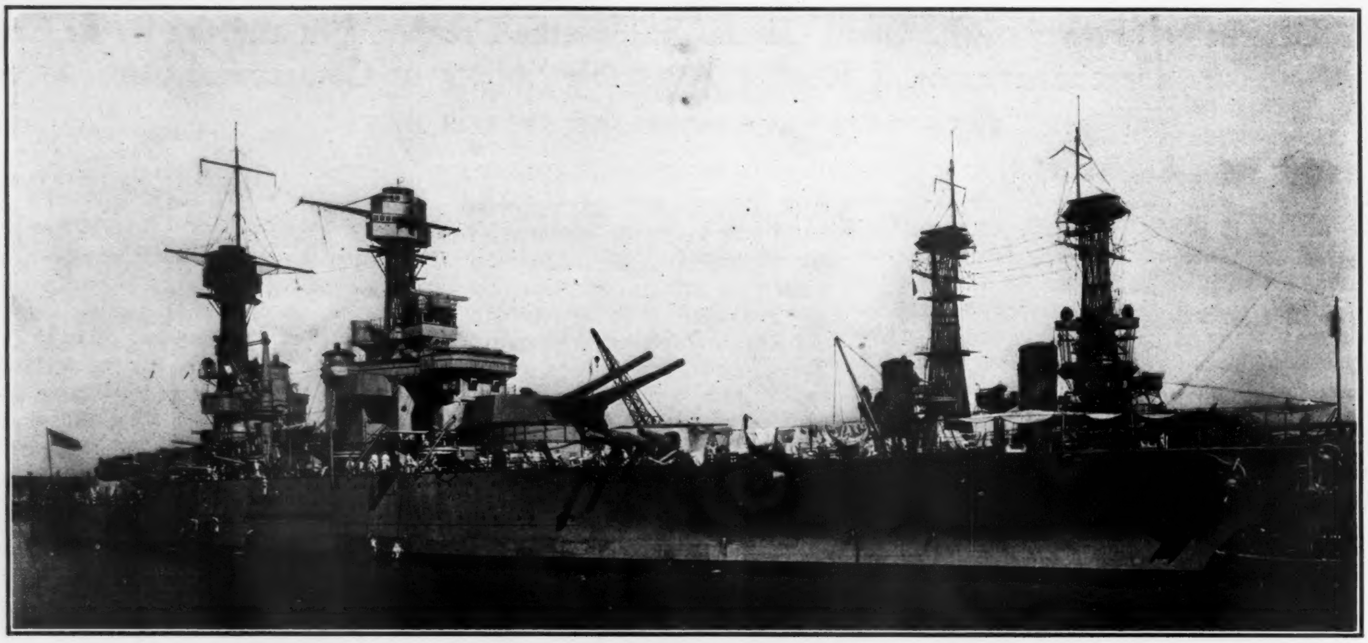
Nelson's ships of the line were said to be the wooden bulwarks of England. They car-



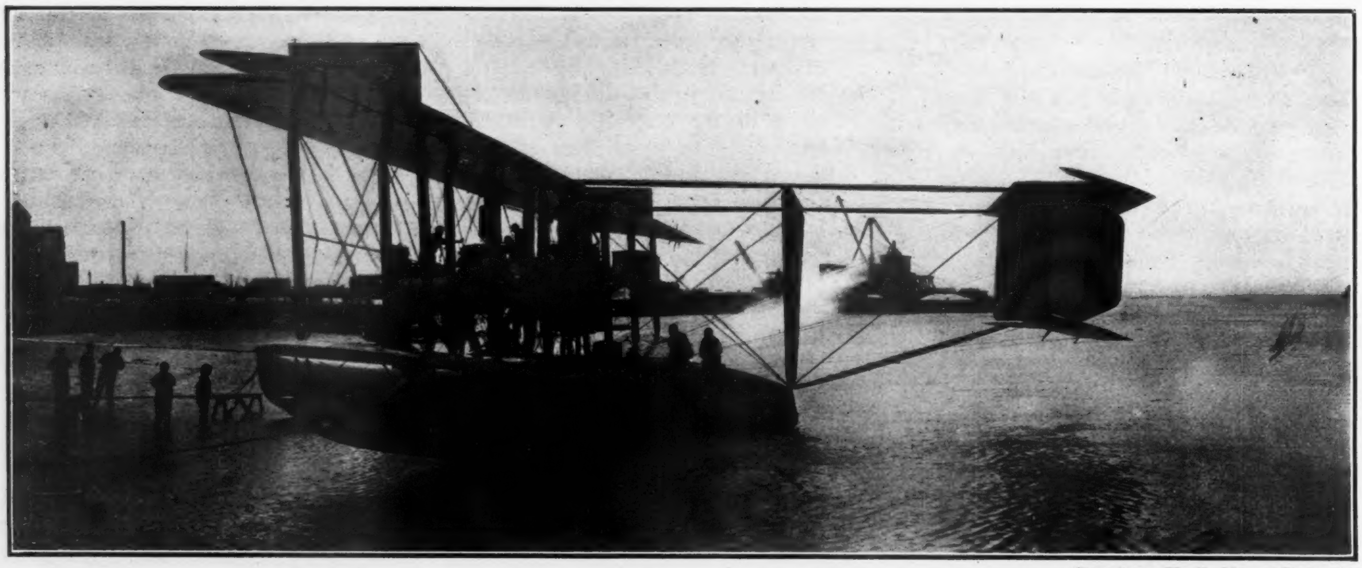
Courtesy U. S. Navy Department.

The new "Indiana" class of 43,000-ton superdreadnoughts for the United States Navy. Appropriation has been made for six of these monster vessels. They are designed to carry 16-inch guns.

The Three Services of the Fighting Fleet

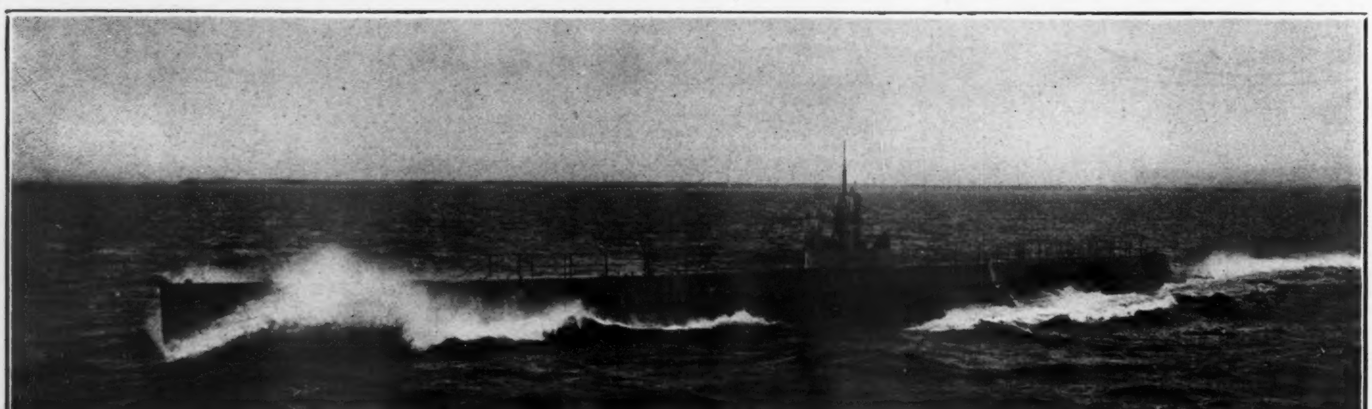


The U. S. "Tennessee" at the Brooklyn Navy Yard, where she was built.



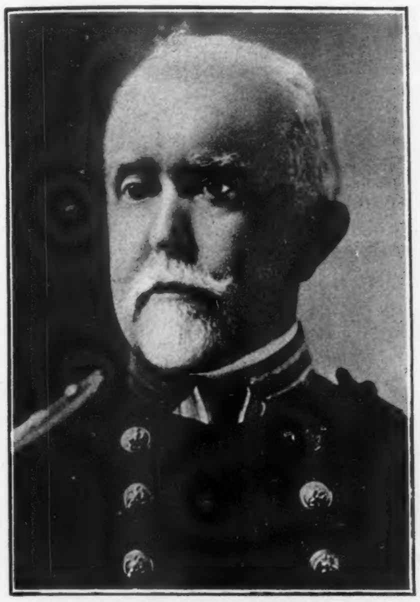
Courtesy U. S. Navy Department.

The famous NC-4 of the flying-boat type which was designed during the World War to cross the Atlantic under her own power to measure forces with the Teutons.



Courtesy The Electric Boat Company.

The most highly developed type of our under-water craft: The U. S. Submarine AA-2, making 20 knots an hour on the surface.



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Rear Admiral Robert S. Griffin, Engineer in Chief of the United States Navy.

ried destructive power to the uttermost ends of the globe and applied it wherever needed. England's commerce, yet, was not immune from attack and capture, but the commerce of England's enemies gradually melted away while the commerce of England increased and spread to every sea. In those days a base to refit was needed and such was had by England wherever her naval fleets were drawn to protect the sea borne commerce of the nation. Having bases all over the civilized globe England's fleet could actually "control the sea."

It could send a fleet to any locality and control it, barring its enemy from the use of those seas. A base for a modern fleet is quite another question. To fit up a base is a task requiring years of labor and the expenditure of a score of millions of dollars. Without a base a modern fleet cannot operate. It would soon fall a victim to the incessant attacks of its enemies from the air and from under the water, for it would not have the facilities at hand to make good the damages. Every torpedo or bomb hit would remain a festering sore. Thus we see that no one nation can control the seas. It can do so only in those areas which lie close to its own territory.

It is a well understood principle of maritime strategy that in order to protect commerce in distant parts of the world, nations must be capable of exerting sufficient force to overcome force which may be exerted there by a possible enemy. It is quite evident that when a nation is dependent upon obtaining supplies and repairs for its fleet when in distant waters through a long line of communications, which at many points may be harrassed by the enemy, it will endeavor to acquire territory in such localities; provided its trade is important enough to warrant the attempt. These advance points become bases for its fleet in war. During peace they are merely commercial ports for the use of its merchant shipping.

The great dreadnought and cruiser battleship are today as in the days of Nelson the bulwarks of the nation. There exist points of difference due to their tremendous size. The ships of Nelson could be "hauled down" upon any friendly sand beach and their bottoms repaired, while a modern dreadnought requires a dry dock 1,000 feet long, over 100 feet wide and 50 feet deep. Such docks require three years to build. Nelson did not have to wait three years after his nation had acquired territory in distant seas before he could repair the bottoms of his battleships. He waited only long enough to have arrive a convoy of naval stores from England.

The capital ships of a nation are in the nature of invested capital, to be drawn upon when required but always maintained ready for instant use and never to be frittered away. In the days of Nelson, England understood the necessity for far flung bases. This necessity is just as great today, only it requires a very much longer time to establish such bases. The lack of such a base for her fleet in the Orient prevents the British Grand Fleet from operating there against an enemy with a base in that locality, and becomes a powerful argument for an alliance with Japan.

There is a reversal of tactical disposition in naval war which has been seized upon by those who declare the battleship is dead. It is a most natural change in the method of attack and accomplishes the purpose as the Allies demonstrated by their victory at sea. Nelson's "ships of the line" bore the brunt of the attack. His frigates, fireships and auxiliaries of different kinds were used only after the "line" was engaged. The menace of the torpedo has reversed the order. The auxiliary weapons now engage first.

On land, the ancients attacked with their foot soldiers massed, their mounted men on the flanks and for pursuit. The advances in modern artillery and machine gun fire have made this method impossible. Now, there is the artillery preparation, then the tanks and after that the infantry. Cavalry and airplanes are for observation and pursuit. So it is with fighting at sea. The ships furthest advanced toward the enemy are the airplane and the submarine, then the destroyer, scout cruiser, armored cruiser, battle cruiser and battleship in the order named. A weakening in any of these links of power might change the control of the sea from one belligerent to the other.

In the Great War, if England had been "short" on submarines, the lookout duty in the Heligoland Bight performed by this type could not have been done. If the air force had been inadequate Germany would have controlled the air over the sea, doing incalculable destruction. If England had been "shy" of destroyers, the enemy submarine could not have been harried, nor could the commerce entering English ports have been so well protected. A lack of scout cruisers would have caused Admiral Jellicoe to fight with his eyes blindfolded. An inferiority of battle cruiser strength would have allowed Germany to operate its own battle cruisers, "sweeping up" the thousands of small warships which cruised in comparative safety against the enemy submarines. And lastly, the dreadnought; if the inferiority of the Grand Fleet over the High Sea Fleet had been demonstrated at Jutland, the entire order of things would have been turned upside down and Germany would have controlled the sea from the moment when that inferiority was proved.

It can be seen that sea power is not an elementary question to be decided on the impulse of the moment by a few apparently convincing arguments from the mouths of prophets. Neither Sir Percy Scott nor General Mitchell are altogether wrong nor are they altogether right. Their opinions will aid in the solution, but their opinions will not be the solution. The final decision as to types to gain the mission of sea power must be made with a clear vision of the entire panorama of naval effort. The naval man has in all ages been condemned for his conservatism. There is too much at stake to encourage radicalism. He holds doggedly to the old and tried out types until the reliability of a new type has been proved to his entire satisfaction. He realizes that his nation's honor in war hangs upon his right judgment in peace.

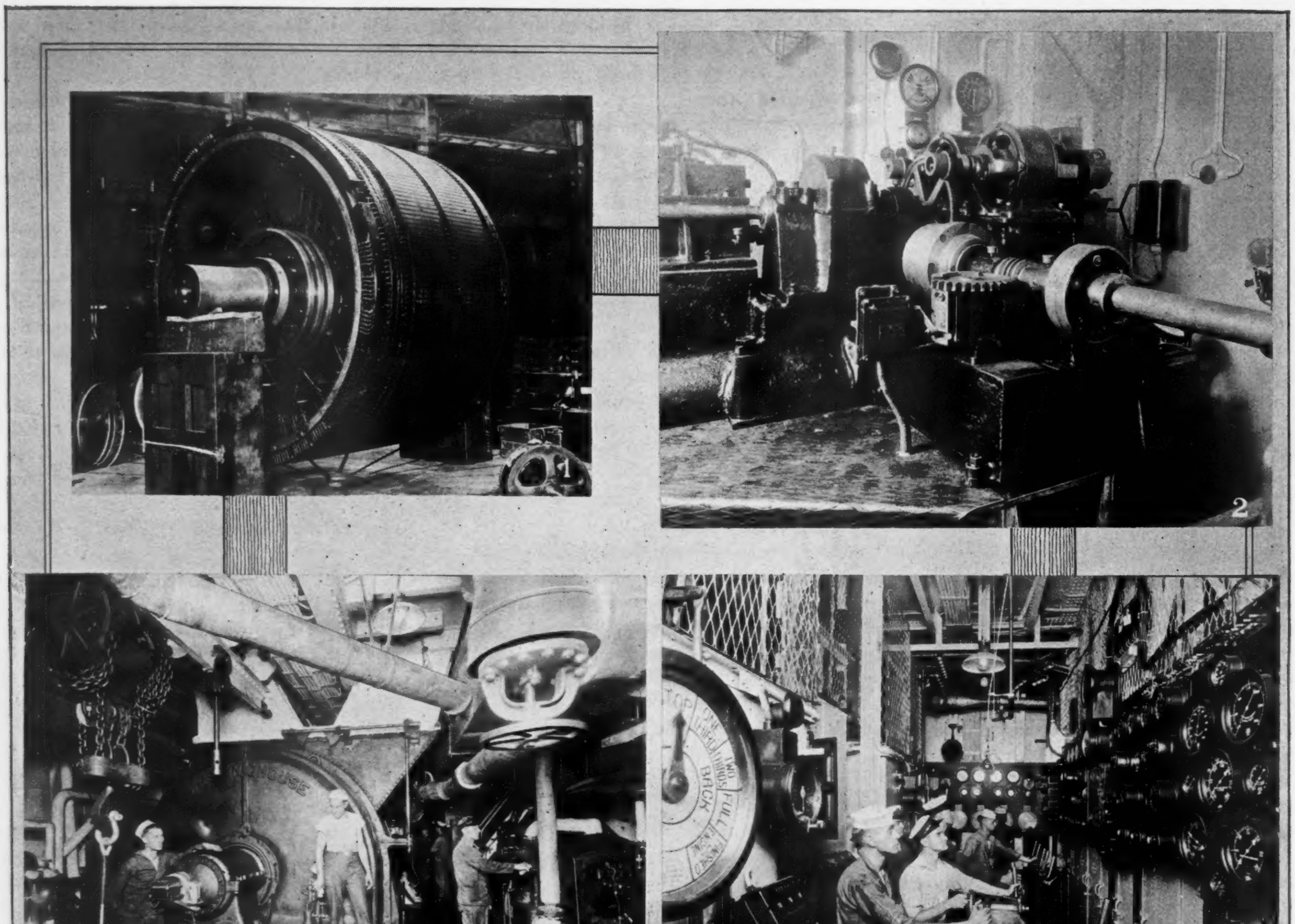
Reliability in new types can arrive only through the more or less slow process of evolution. Nature demands that nothing worthwhile may be accomplished except through that universal law, "Great oaks from little acorns grow," but not in a few months or even years. What the next 50 years will bring to us on the sea, no prophet of this day can with assured accuracy foretell, but within the span of our vision, the great surface "Capital" ship, even though it demands the expenditure of untold wealth remains the backbone of sea power. No nation of prominence on the sea can afford to neglect it.

It is rather a remarkable fact and probably little realized even by the most ardent supporters of compressed air that the destructive power of the great capital ships, the dreadnought and the battle cruiser, is dependent upon that article.

© Underwood & Underwood.

Captain Richard H. Leigh, U. S. N. commanding officer of the U. S. S. "Tennessee," the latest of our commissioned superdreadnoughts.

Interior and Exterior Views of the U. S. S. Tennessee



© Westinghouse Elec. & Mfg. Co.

Fig 1.—One of the great propeller motors. Fig. 2.—Steering gear control mechanism. Fig. 3.—One of the main engine rooms, showing a 20,000 horsepower Westinghouse turbo-electric generator which delivers actuating current to the propeller motors. Fig. 4.—The operative nerve center of the superdreadnought. The control room where a handful of men, at a few levers, have the motive apparatus of the great ship completely at their command. Fig. 5.—One of the turbo generators. Fig. 6.—The forward deck of the "Tennessee" giving a close-up view of one of the winches.

The two weapons of importance are the great turret gun and the torpedo. That the automobile torpedo is dependent for its motive power upon compressed air is not new, but that the monster guns could not be fired with rapidity, as is necessary in battle, without compressed air is not so widely known.

The capital ship may be likened to an industrial plant. It contains within itself all manner of machinery which must be kept at all times in the very pink of condition. To be able to accomplish all manner of repairs, similar facilities are given the ship as are given an industrial station on shore. A large air compressor [sometimes several of them] is installed in the engine room and the air piped to all parts of the ship wherever it may be needed. Air riveters, chipping hammers and pneumatic hammers are daily used by the artificers of the navy.

The military uses of compressed air are far more romantic, and one of them was not discovered until a half hundred daring officers and men had laid down their lives.

The torpedo is not the principal weapon of the battleship, yet it is an important one. A battle fleet without torpedoes fighting one carrying these weapons would be at a considerable tactical disadvantage. The knowledge that the enemy's ships are so armed makes the admirals and captains maneuver their ships with extra caution. They must be sure never to cross areas of water where it is possible that a flock of torpedoes is running silently and maybe, if the sea is disturbed, invisibly in a direction to endanger the big ships.

The compressed air at 2250 pounds pressure is carried in the fish-like belly of the weapon. From this high pressure it is reduced by means of reducing valves; then it is super-heated and after that actuates turbine engines driving shafts and propellers.

The steering of the torpedo is done also through the agency of compressed air. The arrangements for this steering, both laterally and in the vertical, are most ingenious.

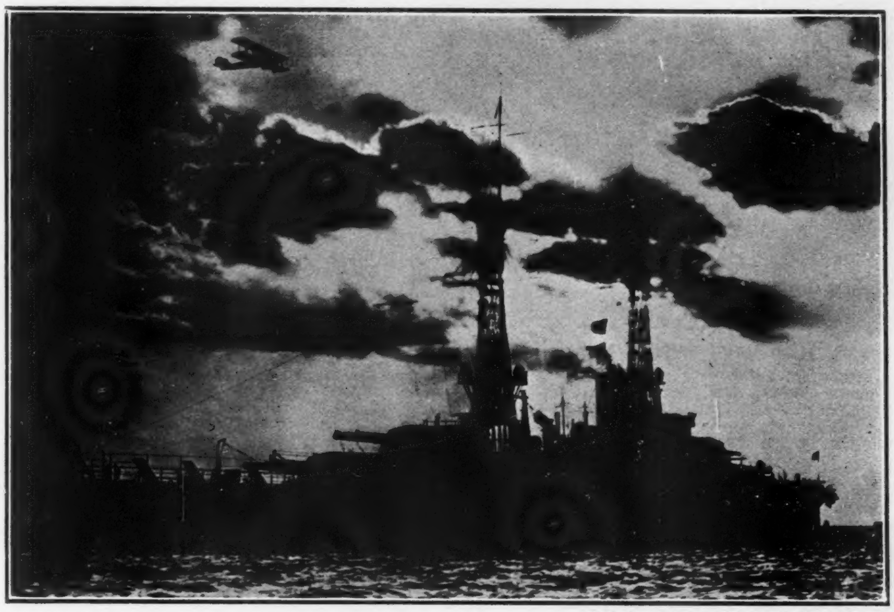
The speed through the water is dependent upon the distance it is desired that the torpedo run. At short range, a high setting of the reducing valve will give a speed of 40 odd knots an hour. For extreme range, say 10,000 yards, a low setting of the valve will cause the turbines to run more slowly, using up the air in a longer time. The speed in the latter case will not be more than 25 knots, and if seen in time the torpedo may be dodged by a battleship.

In the head of the torpedo is carried from 300 to 500 pounds of high explosive and the blow being delivered at a point from ten to fifteen feet below the water line is a most serious one. If it does not sink the ship it will cause it to lose considerable of its "punch."

The torpedoes are fired from tubes installed in large and commodious compartments situated beneath the water line. In these compartments are high pressure air compressors driven by electric motors. The air when charged to high pressure is stored in air flasks or banks. The torpedo is usually charged directly from the compressor through high pressure air pipes.

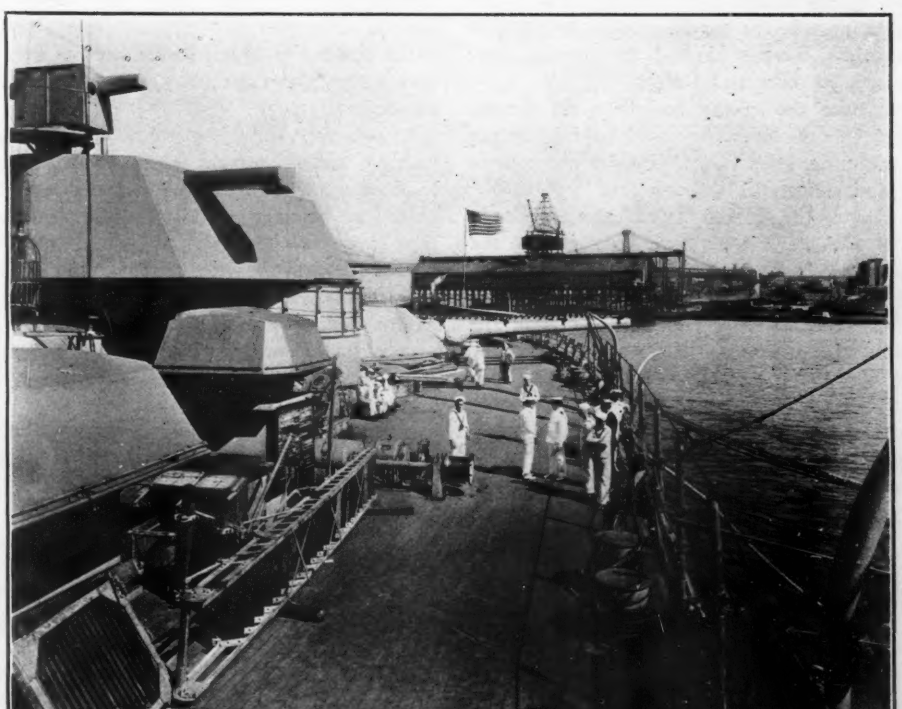
Nearly twenty years ago when the queen of the navy was of the class of the now obsolete *Alabama* and *Wisconsin*, a lieutenant by the name of "Sims," the same who commanded our ships abroad during the great war, undertook to increase the fighting power of our fleet by a few thousand per cent. His method was very simple when once understood. It consisted first of all in training the gun pointers to hit the target and second in increasing the firing of a turret gun from once in five minutes, which was the rate used at the battle of Santiago against the Spanish ships, to once in 30 seconds.

It can be imagined how every motion of loading these big guns had to be hastened to accomplish this result. The huge breech-plug was flung open before the powder gases had all left the muzzle. A shell was rammed home, powder in bags followed and the breech slammed shut almost quicker than the eye could detect. There was an unknown danger lurking inside the gun after firing, of which the experts on ballistics were unaware. The turret crews had observed a white oily appearing smoke while they rammed home the shell.



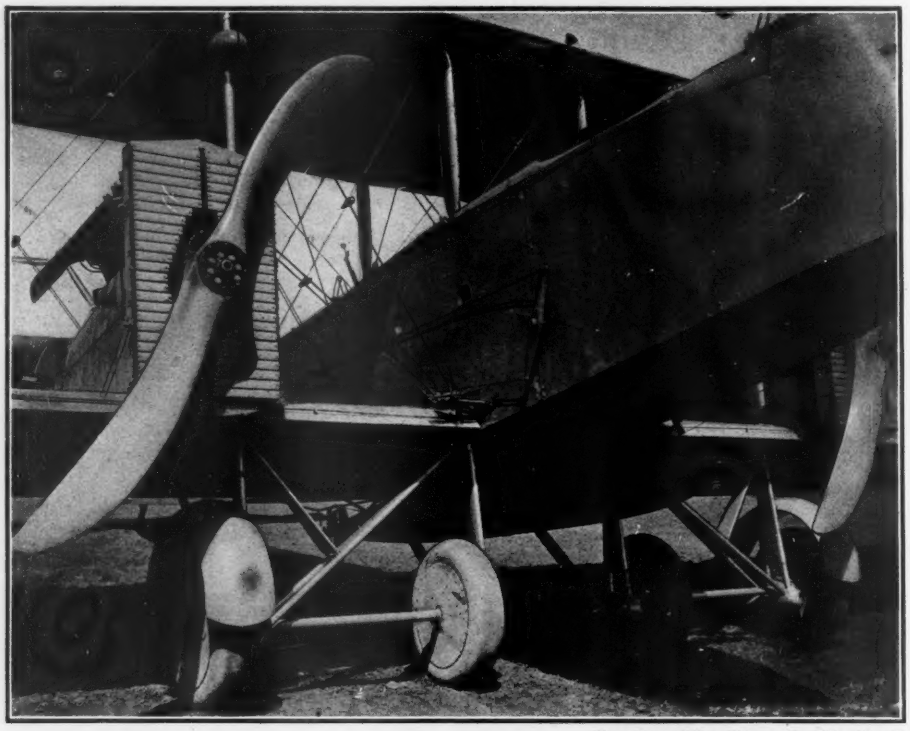
Courtesy The Glenn L. Martin Co.

The U. S. S. "Pennsylvania" with one of the Army's new six-ton Martin bombing planes shown aloft and about to pass over the battleship.



Courtesy Westinghouse Elec. & Mfg. Co.

The after deck of the U. S. S. "Tennessee" showing two of the turrets which house her formidable 14-inch rifles.



Courtesy The Glenn L. Martin Co.

A potential menace to the greatest of fighting ships: the torpedoplane. The torpedo can be seen lying close beneath the fusilage of the flying machine.

When the wind blew into the muzzle this smoke had drifted out from the breech into the turret. One day an incandescent particle of an unconsumed powder bag clung to the inside of the powder chamber. The oily white smoke revealed its character and burst into flame. It ignited two bags of powder at the breech of the gun, ready to be pushed home. The inside of the turret became instantly a mass of flame. Two more powder bags beneath the guns added to the destruction and several more in the handling room twenty odd feet below further kindled the funeral pyre of nearly 50 officers and men.

But once the enemy had been discovered, driven into the open, he could hold no terror for the naval man. Compressed air overcame him and rendered him harmless.

At first the remedy was executed very crudely. A flexible air hose, connected to the torpedo air banks was carried into the turret. The powder was kept clear of the breech of the guns until the breech was open and the stream of compressed air directed into the breech, forcing the oily white smoke out through the muzzle. When the bore was clear then the danger was passed and the gun could be loaded in perfect safety.

Later most ingenious arrangements were designed and installed, not only on turret guns but on every gun that used powder put up in bags. The general idea of this design was to form at the breech of the gun a helix of air, just in front of the mushroom head of the breech plug, and to admit this air at about 100 pounds pressure while the plug was opening, and so as to have the bore clear by the time the plug was wide open. To accomplish this several minute holes were drilled through the gun, opening into the bore so as to be behind the gas and expel it at considerable speed toward the muzzle. The air valve was opened by a cam on the face of the plug and closed by hand after it was seen that the gas had all been expelled. Special air compressors and piping were installed by the Bureau of Ordnance of the Navy Department.

These casualties were familiarly termed "flare-backs" and for a time threw great consternation into those responsible for the design of naval ordnance. Now, thanks to compressed air, flare backs are things unknown. However, no turret or broadside gun using powder in bags may be fired at practice unless the "Gas expelling system" is in working order.

In some late ships it is proposed to use compressed air in certain compartments which might be bilged by torpedo explosion. The basic idea being to meet force with force and thus overcome the serious consequences of having several compartments of large size flooded, thereby giving the ship a list which would reduce the speed, detract from the maneuvering qualities and possibly throw some important guns out of action.

Without compressed air the submarine could not operate, with safety, submerged; without that wonderful "force" the battleship could not, with safety, shoot.

SAND FOR THE MAKING OF GLASS

THE FOLLOWING we condense from the publication *Bottles* of the Illinois Glass Company:

The average person knows that sand is one of the principal ingredients in the making of glass, but that is about all. And because it is such a common substance and is found on beaches, river bottoms and, in fact, all over as one of the very basic geological elements of the earth's surface, he rather unconsciously figures that all you need to go with it is a little heat and presto—you have glass.

But the kind or quality of sand that is employed in glass making is of the utmost importance. The color, transparency and brilliancy of the glass are very largely determined by the chemical and physical properties of the sand itself. This raw material must analyze 99 per cent. pure silica or silicon dioxide in its natural state, be perfectly dry in order to mix properly in the batch, and contain no particles that will not pass through a ten-mesh screen. Nature has deposited a sandstone that analyzes very much as the above, but, like many desirable things, she has hidden it deeply in her bosom so that it is difficult to get at.

The sand that we use in our various glass factories is a beautiful snow-white product that looks like pulverized sugar. It is not a commodity that we can scoop out of the lake nor the river bottom, but has to be quarried as though it were marble or granite, then crushed by machinery and put through a drying process.

In our quarry on the Missouri River, for instance, from which we get the sand that is used at Alton, the vein of sandstone is covered in some places with from two to ten feet of dirt. This is washed off by means of high water pressure, administered through a hose with a small nozzle.

In other places two to ten feet of low grade limestone must be removed and wasted. Then a vein of silica is reached that is only good for steel casting molding sand. This vein is drilled with air drills, quarried, and, after being treated, is sold to the steel foundries. The next 40 to 60 feet is a very high grade glass sandstone, which must be drilled and blasted with great care so as to keep it separate from the molding sand. The latter is a much harder stone and the grains are more firmly bound together.

The raw material is then hauled to the mill where it is passed through a large gyratory crusher and then fed to two pairs of large rollers. It is then dried and all the coarse sand screened out—the fine going into the material bins to make up the first grade glass sand, while the coarser particles are carried to additional rollers and all the foreign matter removed by means of a shaker screen. This second crushing produces a grade of material that is just what is required for cores in the manufacture of brass, iron and steel castings.

SAND-SUCKER MINING

Operating under license from the Ontario Department of Mines, sand-suckers working on the bars and shoals in the beds of the Great Lakes and rivers in 1920 recovered 1,456,417 cu. yd. of sand and gravel, valued at $830,634, according to Bulletin 41 of the department. Output of sand and gravel in Ontario increased nearly 100 per cent. in 1920 over that of 1919. Revenue to the province from the source noted approximated $100,000 for 1920. The use of the sand-sucker in mining operations suggests interesting possibilities of recovery from submerged beaches or ledges that are thought or known to be mineralized.

Air Hammer vs. Hand Power in Dumping Ore Cars

EXHAUSTIVE TESTS were conducted during the past season at the Great Northern Railroad Company's ore docks at Allouez, Wisconsin, in connection with the dumping of ore cars by aid of air hammers. As is quite generally known the ore equipment is of the hopper bottom type and when the cars are spotted over the ore dock pockets and hoppers opened, contrary to natural supposition the ore does not, as a general proposition, release very rapidly.

This makes it necessary for the ore punchers to give the sides of the car a great number of well-directed blows, with their steel bars, in an effort to loosen the ore sufficiently to get a hole through body of the load. More trouble is, of course, experienced with the old type of equipment, especially the cars with a center beam though even with the most up-to-date dumping devices an appreciable amount of trouble is encountered in dumping particularly the washed ore.

The settlement of the load enroute from the mines to the docks, switching, etc., of necessity, results in receipt at destination of a compact mass.

These "air hammers" so-called are in reality a battery of four Ingersoll-Rand tie tamping tools fitted up with special steel to meet the conditions. These tools were selected from a number of types that were tried out for the reason that they can be easily handled by the operators; the weight and rapidity of the blows with which the piston strikes the steel are sufficient to set up the required vibration but not excessive enough to damage the cars in any way.

The length of the tool is also of advantage in that it permits the operator to place the steel in places on the car which would be difficult to reach in any other way. The improvised installation used in conducting the tests consisted of an electric driven air compressor, a two and one-half inch pipe line the length of the dock with offsets every 50 feet to which the "air hammers" were connected as the location of the cars warranted. It was found that the most satisfactory results were obtained by assigning two hammers to a car,—each manned by two laborers,—one hammer on each side of the car,—the operators hammering the car until such time as a hole was punched through the ore. The essential thing in ore dumping is to get this hole through, the balance of the dumping then simply resolves itself into a "punch-bar" proposition, that is, a laborer with a steel punch bar stands on top of the car and punches the ore body until the car is completely dumped, it being a comparatively easy matter once the hole is through.

The test involved the handling of some 1900 cars by aid of the air hammer, in getting the hole through plus use of punch bar, in completing unloading as against the dumping of a similar number of cars through the medium of hand power or punch bars only for the entire operation. The results obtained were eminently satisfactory it having been demonstrated that a saving in time of some 60 per cent. was accomplished in utilizing the air operated hammers with corresponding saving in labor costs, car hours, etc.

Fifty-six of the new type, 70 and 75 ton ore cars, in use by the Great Northern the past season were dumped so rapidly, by aid of the air hammers, that only two minutes time on an average was consumed per car in releasing the entire load.

The Great Northern in line with their custom to avail themselves of any practices conducive to minimizing handling costs were responsible the past season for some pioneer work in regard to letting of contract to a reliable firm of contractors, Peppard & Fulton, for the dumping of ore from cars to docks and from docks to boats on a per ton basis. These contractors handled the situation rather uniquely in that in addition to rate per hour paid, the laborer was assured of a bonus at the close of the season providing he stayed with the operation the entire season.

Notwithstanding the fact that labor was scarce at the Head of the Lakes, the work was handled in such a manner as to result in a continuous operation of the dock facilities the entire season of navigation, a condition which has not obtained heretofore in the history of ore handling at the Head of the Lakes. It is very possible other companies will fall in line in handling the ore dumping by air hammer and through the medium of a contractor's personnel.

It can be readily seen that anything which may be done to speed up the unloading of these cars naturally results in providing a more elastic car supply to the mine operators, creates an enviable handling-cost-per-ton sheet, speeds up boat dispatch, and in general has such far-reaching effects as to make this phase of the ore handling situation worthy of the utmost consideration.

The installation of permanent equipment is now going on, and will be completed in time for use at the opening of the coming season.

Mr. E. A. Clifford who has been manager of *Electrical World* has been appointed executive secretary of the McGraw-Hill Co., and Mr. L. W. Seelingsberg, who has had the latter position, is now manager of *Electric Railway Journal.*

An Imperial pneumatic tie tamper tool hammers the car sides to dislodge the ore.

INFLUENCE OF SUBMERGENCE ON EFFICIENCY OF AIR LIFTS

By H. T. ABRAMS

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THE GENERAL recognized basic formula for determining the air required to raise water is—

$$V_a = \frac{h}{C \log. \dfrac{H + 34}{34}}$$

where:

V_a = Free air (actual) required to raise one gallon of water.
h = Total lift in feet.
H = Running submergence in feet.
C = Constant as given in table.

In this formula the constants "C" were based originally on lift, and there was no correction offered, or suggested, for any variation in submergence, the constants being based on the best ratio of submergence to lift.

It will be readily understood that this limited the value of the formula, because it is not always possible to obtain the best ratio of submergence even if the best ratio was known. Wells are frequently not deep enough to provide for this necessary best submergence, or it may happen that in industrial or metallurgical installations that the preparation for a master well for submergence is expensive, and should therefore be as limited in depth as possible, or it may not be entirely a matter of expense alone, as there may be some limiting condition affecting the possible depth of such a well.

Realizing the necessity for a set of constants to correct the formula for different ratios of submergence within the limits of what is considered good practice, the author revised the original constants "C" to meet this demand.

The constants do not apply to small discharge pipes—two inch diameter and under.

The table given below not only gives the constants "C" for different submergences, but also attempts to point out the best ratio of submergence for any lift, calculated on the basis of horse power cost to compress the air per gallon of water pumped.

Carried further, the formula, together with the table, will permit calculations to be made showing the relative efficiency, or cost per horse power per gallon, with any given lift and any given submergence within the limits of the table.

TABLE OF CONSTANTS

Submergence ...	75%	70%	65%	60%	55%	50%	45%	40%	35%
Constant "C"...	366	358	348	335	318	296	272	246	216

TABLE SHOWING CUSTOMARY ALLOWABLE AND BEST SUBMERGENCES

Lift in Feet.	Customary Allowable Percentage Submergence.	Best Percentage Submergence	Single Stage or Compound Air Compressors.
20	55 to 70	(65-70)	Single
30	55 to 70	(65-70)	"
40	50 to 70	(65-70)	"
50	50 to 70	(65-70)	"
60	50 to 70	(65-70)	"
80	50 to 70	(65-70)	"
100	45 to 70	(65-70)	"
125	45 to 65	(65)	"
150	40 to 65	(60-65)	"
175	40 to 60	(55-60)	"
200	40 to 60	(55-60)	Compound
250	40 to 60	(55-60)	"
300	37 to 55	(50-55)	"
350	37 to 55	(50-55)	"
400	37 to 50	(45-50)	"
450	35 to 45	(40-45)	"
500	35 to 45	(40-45)	"
550	35 to 45	(40-45)	"
600	35 to 45	(40-45)	"
650	35 to 45	(40-45)	"
700	35 to 40	(40)	"

LIQUID AIR IN ENGLAND

RATHER differently from what might have been predicted, the use of liquid air for explosive service has been carried much farther, and may be considered more firmly established, or nearer to permanent adoption, in England than in the United States. The reason doubtless has been that apparatus for the production of liquid air has been more generally distributed than with us.

So far as mine rescue is concerned, the utility of liquid air has already been established, says *Iron and Coal Trades Review*, in the Notts and Derbyshire coalfields, as liquid air plants have been installed at the Chesterfield, Mansfield and Ilkeston rescue stations. A demonstration of what it can do in blasting was recently given by the Liquid Air and Rescue Syndicate, Ltd., at the Peasley Junction quarries.

The syndicate, the headquarters of which are at Park Royal, London, was formed in 1913 with the object of manufacturing liquid-air plants. At that time liquid air was looked upon as a scientific curiosity, but the fact that the syndicate has supplied plants to various centres in this country and the colonies for mine rescue work is evidence of it having reached the practical stage. Experiments with a view to ascertaining its further utility were being carried out in 1914, but these were interfered with by the outbreak of war. After hostilities had ceased, however, the experiments were proceeded with, and it was found that liquid air could be utilized with marked effect as a constituent of explosive.

The explosive consists of a cartridge formed of a stiff paper wrapper filled with carbonaceous material, which varies according to the work to be done. Filled with cork dust, sawdust, peat, or similar material, the cartridge itself is non-inflammable and perfectly harmless The other component is liquid air which contains about 90 per cent. of oxygen. The cartridges are soaked in liquid air for a brief period, usually five minutes, and are then taken out, being ready for use immediately or during the space of fifteen minutes. They can be fired either with a detonator or an ordinary safety fuse. An important factor in connection with this explosive is that, in case of a miss-fire, the cartridge can, after a lapse of time, be taken out with safety, as the liquid air will have then evaporated.

The blasting was carried out in magnesian limestone, the boreholes being 1½ in. diameter. The holes were placed as required for the ordinary working of the quarry, and the stone being required for lime burning the charges used were, except in the final shot, for producing a shattering effect. All the shots were fired electrically, one of the cartridges in each case having a No. 6 detonator affixed, placed as near the centre of the charge as possible. The cartridges were dropped into the holes without special precaution and pressed down with a wooden rammer, ordinary earth stemming being used. The particulars of the shots are as follows:

Depth of hole.	No. of cartridges and size (mm.),	Results
Ft. 8	Six 35x300	Rock well shattered, but not a great quantity actually pushed out.
8	Seven 35x300	This shot was immediately behind No. 1 and was quite a success, shattering and displacing its own section and also the loose stone of No. 1.
5	Seven 35x300	Very good, the rock being well shattered and displaced.
5	Three 35x200	Do.
6	Five 35x300	Do.
6	Two 35x300 Two 35x200	Do.
7	Five 35x300	Very good; rock well split into useful sections.

The holes were in each case placed at a distance from the face approximately equivalent to the depth, the holes being bored vertically; the shots were fired in approximately three minutes from the time of commencing to insert the cartridge.

Great Britain has made public details of an entirely new type of seaplane which can either fly or cruise as a warship.

NOVEL COMPRESSOR LUBRICATING EXPERIENCE

By C. E. ANDERSON.

[The following interesting narrative of compressor lubricating experience, which we reproduce, with some condensation, from a recent issue of *Power Plant Engineering*, has to do entirely with an ammonia compressor, but the point of it should be equally appreciated in straight air compression.]

A letter came one day in the early part of the summer from a confectionery store in Ohio, stating that they could not run their refrigerating plant, and wanted a man to come and fix it at once. I called the proprietor of this store on the long distance 'phone and inquired what the trouble was. He answered that the compressor would not turn over. They had tried to turn it over with bars on the flywheel spokes, but could not budge the machine.

In going to the plant, I tried to diagnose the trouble and felt reasonably sure that they had operated the machine without a sufficient amount of oil in the crankcase, and that the pistons had run hot and "froze" to the cylinder walls. This is a very common occurrence.

The machine was of the vertical enclosed crankcase, high-speed type of five ton capacity. The machine had been acting rather peculiarly for several days, I was told, and on the last day that the machine was operating it blew out all the fuses they had, and then some "wise guy" told them to use hay wire instead of fuses and they would have no more trouble. This advice they followed, with the result that main fuses at the transformer, outside on a pole, were blown out. When they had power again, they tried to run the compressor and found that they could not turn it over.

I looked at the oil gage on the crankcase of the machine and it seemed full, at least the glass was black its full length. I began to doubt my diagnosis on the train. The cylinder heads were removed, in order to look at the cylinder walls and pistons. On removing the cylinder heads, I found the discharge valve and chambers choked up with a gluey, gummy mass, having a peculiar sweet smell. Never before had I seen oil look like that, and I suspected right away that something besides oil had been pumped into the crankcase. The crankcase cover was the next thing to come off, and we found the crankcase one solid mass of this gluey, gummy stuff, with a few hard lumps in it about the size of an egg.

I showed all this to the proprietor, and asked him what kind of oil he was using. He showed me a barrel in one corner of the basement that he had purchased only three weeks before. This barrel proved to be a well-known brand of zero oil and was O.K., but the barrel had never been tapped. This fact I brought to his attention. He sent upstairs for a young fellow who operated the plant and questioned him about the machine, especially about the oil he used in the crankcase. He replied that when he was hired (about the same time the oil came) he was told to keep the oil about in the middle of the oil gage glass and to use the oil out of the red barrel. This he claimed he had done at all times. He was next asked how he got oil out of the barrel, when it was not as yet opened. He answered by taking us over to one corner of the basement and showing us a little red barrel (half barrel) standing on a packing case, with a spigot on it. This is the oil he used, just as he was told to do. He opened the spigot and drew off some of this oil. It smelled sweet, just like the stuff in the crankcase. I lit a match, as it was rather dim, in order to read the label on the head of the barrel. It was a nicely designed label and it read, "This half barrel contains 16 gal. Coca-Cola Syrup."

THE FUNCTION OF MOISTURE IN COMBUSTION

NOTWITHSTANDING that combustion is simply combination of some material with oxygen, the curious fact has been observed that without moisture present some of the most active chemical combinations cannot be effected at all. This matter was presented in an interesting way in *Fire and Water Engineering* recently.

It is well known that iron will not rust even in pure oxygen unless there is present at least a *trace* of moisture. The action of moisture in oxidation belongs to the general class of phenomena known as *catalysis*, and the water is looked on as a *catalyst*. A catalyst is a substance whose presence is quite essential in order that two other substances might combine chemically, but which does not, itself, enter into the combination. It might be likened unto the spark which ignites the powder cask and causes the explosion. The spark is necessary to get the thing started, but the explosion itself partakes of nothing contributed by the spark.

Most of the phenomena of combustion are absolutely dependent on the presence of water vapor without which they cannot be realized and the phenomena of spontaneous combustion are pertinent examples of these. In a perfectly dry atmosphere a log of wood will last for centuries, though freely exposed to the oxygen of the air all the time.

That the water does not enter into the reaction may be seen from the fact that a log of wood completely submerged in water to the entire exclusion of air or other active source of free oxygen will last forever, though the water contains more oxygen than does an equal weight of air. In the air, the oxygen is *free* and simply *mixed* with the nitrogen with which it is associated, whereas in the water the oxygen is in actual chemical *combination* with the hydrogen with which it forms the distinct and totally different chemical substance, water.

It is understood that the engineers employed by the Special Joint Congressional Committee to investigate pneumatic tube postal service in the cities where such service has been installed, but is not now in use, have recommended to the committee that the pneumatic service be restored in New York and Brooklyn postal districts. The American Pneumatic Service Co. is especially interested in the favorable report of the engineers on the New York and Brooklyn situations.

COMPRESSED AIR AS AN AID TO SOLDERING

THE ENTERPRISING Teutons have latterly made interesting experiments looking to the further industrial use of compressed air. As most of us know, the time-honored technique of soldering has undergone but little material alteration since its inception, and the great bulk of this work is still done by the well-known—one might say primitive—hand procedure.

Recently, however, tests have been made abroad to establish the feasibility of spraying solder onto the two metallic surfaces to be joined. While these essays have not been conclusive in their revelations, still they have brought out enough to warrant further research. The so-called Schoop system of metal spraying was employed during the experiments.

The molten or plastic solder was deposited in an atomized state by means of compressed air. Various expedients can be resorted to to bring about a satisfactory union between the solder and the receiving metal surface upon which it is projected. For instance, the solder can be atomized on at short range so that it will remain sufficiently heated and plastic to adhere in a homogeneous layer. The deposited solder then has substantially the same appearance as if it had been poured on.

Another method tried out consisted, first, in applying the solder in the form of a spray by compressed air and, next, in manipulating it by means of a soldering iron of flame. This, of course, involves two operations, while the preceding system achieves the desired result with but one. In practice some technical difficulties have been encountered, as might be expected, such as the proper regulation of the temperature of the metallic surface to be soldered and then the effect of the compressed air on the solder, itself.

In the case of metals with low fusing points it was practicable to secure comparatively good results; and the soldered seams had the familiar appearance. However, the two-stage process was, on the whole, found more satisfactory despite the dual functions. The sprayed metal can be easily spread, after its initial contact, with either an ordinary iron or by flame. Excellent results were realized in soldering or welding lead. With zinc, alloys, and soldering mediums of low melting characteristics soldering generally by spraying or atomizing was readily accomplished. These researches abroad are of suggestive value, and probably other people interested industrially in soldering may thus obtain a hint of potential usefulness.

The member companies of the great German dyestuffs and chemical combine are considering a proposal to form a limited company with a capital of 500,000,000 marks in connection with the extension of the nitrate production in Germany. It is planned to take over the nitrate works at Oppau and Merseburg, hitherto operated by the Badische Anilin & Sodafabrik. The project involves sanction to the extension for a number of years of the existing working agreement in the dyestuffs industry.

TUNNEL DRIVING IN PENN. ANTHRACITE FIELD

*By HUGH DOLAN**

THE FIELDS of Pennsylvania are the most important deposits of anthracite in the country. The first information on hard coal, or anthracite, dates back to 1791, when, as the story goes, a hunter and trapper named Philip Ginter found several pieces of hard black substance which he recognized as coal, exposed among the roots of a tree on the top of Sharp Mountain, between Mauch Chunk and Summit Hill.

After many discouragements and dangers a few loads were taken down the rapids of the Lehigh River to Philadelphia. However, the people there did not at that time take kindly to burning "black stones" and the first shipment was condemned as worthless. It was not until the completion of waterways and railways to the important outlets in the East, about 1820, that the anthracite trade flourished.

The Pennsylvania anthracite field is confined to five counties in which coal mining is the principal industry. If all the coal land in these counties was brought together in one body the result would be an area about twenty miles square. This area appears insignificant when compared with the vast extent of our bituminous coal fields, and the importance of the district can only be fully appreciated when considered on the basis of the number and thickness of its many coal seams, the great quantity of coal per acre, and the superior quality and immense tonnage of coal produced.

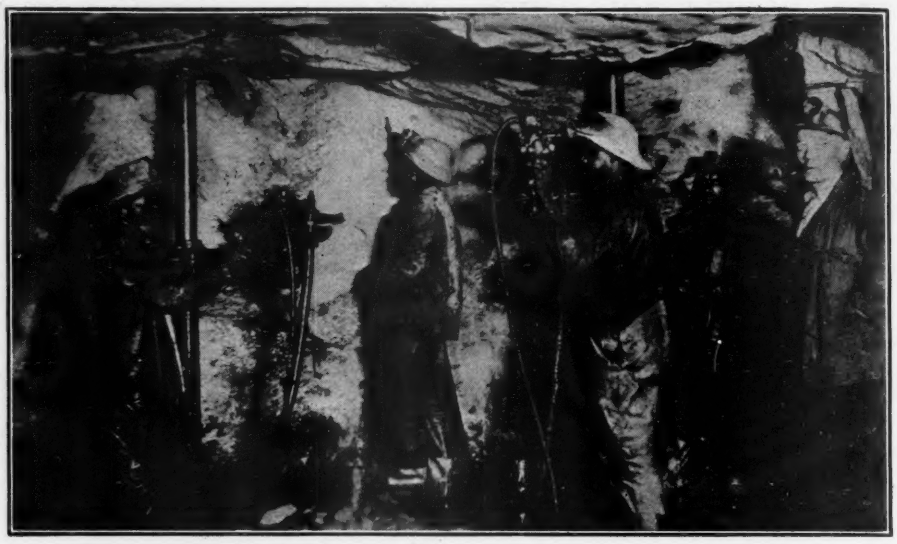
The tunnel that was driven by Hugh Dolan and described in his own words in the following article was constructed for the purpose of developing one of the mines of the Philadelphia and Reading Coal and Iron Company, one of the very large coal mining industries in the anthracite region. This company has about 50 distinct operations, including both collieries and washeries, in the field. Here is Mr. Dolan's story of the Keffers Tunnel project:

Keffers Tunnel is one of a series of three tunnels driven for the Philadelphia & Reading Coal & Iron Co. in the development of Tower City Colliery, near Tower City, Penn.

These tunnels, approximately one mile apart and at about the same elevation, 1,250 feet above tide, are driven through the Pottsville conglomerate, cutting all the Lykens veins and into the overlying measures, cutting the Buck Mountain, Skidmore, Mammoth, Holmes and Primrose veins. In sections Keffers is eight feet above rail and twelve feet wide, with a drainage ditch at one side that is a foot deep (below sill) and two feet wide, and is 2,056 feet long.

Many years ago a tunnel 337 feet long was driven at this point but was abandoned before any coal was cut. This old tunnel was widened and continued for 1,719 feet to the Primrose vein, 2,056 feet from the portal.

The methods employed in driving were those in general use in the anthracite region and the exceptionally good progress made was due to organization and equipment. Two No. 248 Ingersoll-Rand drills, mounted on columns, were used, supplied with air by an Ingersoll-Rand XB compressor, electrically driven. The tunnel was ventilated by an American Blower Co. Sirocco reversible fan, motor driven, supplying air through a twenty-inch steel pipe.



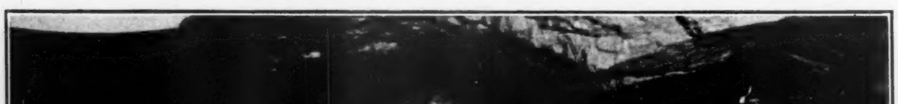
Drilling a round of holes in the hard conglomerate through which the Keffers tunnel was driven. An average of 7.2 ft. of rock was pulled with each round of holes blasted.

Hercules 60 per cent. L. F. Gelatin and No. 8 electric exploders were used exclusively, and all holes were tamped with sand made up in tamping bags supplied by the Hercules Powder Co. Seventeen and seven-tenths pounds of gelatin and 4.6 exploders were consumed per lineal foot of tunnel driven, equal to 4.37 pounds of gelatin for each cubic yard of excavation. In view of the hard conglomerate through which this tunnel was driven, this was an economical powder cost.

The single shift system was used; viz., one drilling shift and one mucking crew. The drillers went into a clean tunnel, setting up the drills and drilling and blasting a complete round; the muckers cleaned up the loosened material, laid road, and took up the ditch. This ditch was blasted with the round, the lowest side hole being drilled low enough to break it, and it was excavated ahead of the ventilating pipe, which was laid over the ditch on cross ties. An occasional short hole was necessary to complete the ditch.

Twenty-one holes, nine and ten feet deep, were drilled in each cut arranged as shown in the accompanying pictures. One thousand seven hundred and nineteen lineal feet were driven in 238 cuts, an average of 7.2 feet per cut. The maximum drive was made in June, 1920, when 245 feet were driven in 29 cuts, an average of 8.4 feet per shot.

The present Hungarian government is declared to be one of the chief obstacles to the resumption of trade with the countries of Central Europe, but Paris and London hope for a more liberal administration in the near future. New and succession states created by the Peace of Versailles are not trading with one another because of racial jealousies. There is a plan afoot for a conference, probably at London, of representatives of countries concerned, Poland, Czecho-Slovakia, Austria, Hungary, Roumania, Serbia, Bulgaria and Greece, to straighten out trading complexities for the good of them all.



Showing the breast of the tunnel after a round of holes loaded with Hercules 60% gelatin had been blasted.

*Reprinted from "The Hercules Mixer."

A Prehistoric Air Compressor

Simplicity, Full Volumetric Efficiency, Pure Air, Cool Air, Air Dry as Any, No Lubrication Troubles

By FRANK RICHARDS*

I DO NOT feel at liberty to say how there came to me the detailed knowledge of the device here presented; and, in fact, if I so wished, I would find it difficult to put the particulars into readable shape. The only thing of which we may all be assured is that, as my title suggests, it is really and truly prehistoric, or, in other words, it antedates all history of it, and no word or print of it is to be found no matter how far back our search may be extended.

An incontrovertible and suggestive characteristic of this device, as bearing upon the antiquity of it, is its extreme simplicity. If we take the trouble to run over in our minds the progress of development of any of the world's most valued and now most indispensable contrivances, we find invariably that the first idea was extremely crude and the first embodiment of it most elementary.

When it had been found that the thing, whatever it was, would actually work, and would do something like what was wanted of it, then the task of improving it began, the improvement always consisting of the adding of successive chunks of ingenuity and complication one after another. This would be likely to go on for an indefinite period until later there would come a realization of the everlasting principle that an addition is not always and necessarily an improvement, and that at the last many of these improvements may be discarded and the thing ultimately restored to its pristine simplicity; but it is only the first stage of this simplicity and not the last with which we are here concerned.

When we come to think of it the mechanical compressing of air cannot well be anything but a simple operation, and it would seem that it could only be done by simple means. The crude sketch, Fig. 1, here presented embodies every functional and essential feature of the prehistoric compressor of which we are to speak. It would seem to be entirely self-explanatory, and words of description should be superfluous. At the right is a vertical cylinder with a reciprocating piston as of an ordinary water pump, and at the left is another cylinder, without a piston of approximately equal capacity in which the actual operation of compressing the air takes place. This separate compressing cylinder at once suggests the separate condenser of James Watt, but the functions of the two are not comparable, either by contrast or otherwise.

When the water piston descends and has reached the limit of its downward stroke, which limit should be, as indicated by the dotted line, slightly below the partition between the two cylinders, then all the space below the piston, the entire compressing cylinder and all the connecting chambers at the bottom are filled entirely with water.

This may be taken as our starting point in describing the complete cycle of operation. When the piston rises in its return stroke, the water in the compressing cylinder descends and then passing to the other cylinder follows the piston in its upward stroke, while the compressing cylinder is filled with free air entering through the inlet valves. Of these valves there are here assumed to be three, only one appearing in the sketch. When the piston has reached the upper limit of its stroke the compressing cylinder is filled with air and the inlet valves automatically close. Upon the descent of the piston the water rises in the compressing cylinder and the contained air is compressed and then expelled through the discharge valves, the water being in sufficient quantity to follow up the air until all of it is driven out, leaving no unfilled clearance space. This cycle of operations is repeated with each double stroke of the piston, leaving not another word to be said in explanation of the air compressing operation.

The sketch here presented is only intended to show the principle of operation as above described, and nothing is meant to be even hinted at of the ultimate details of design and construction for practical service. It will be sufficiently evident that the valves here shown are not "prehistoric," and it may be assumed that in any machine of sufficient size the two cylinders will not be comprised in a single casting, and that neither cylinder will be integral with the base. Any good designer will be able to settle these things according to the capacity, the working pressure and other details of the individual machine.

Now, I must contend that there is no dishonesty or untruth in my designation of this compressor and no deception except as the reader may deceive himself. The machine as shown is really and truly prehistoric in that it precedes all history of it, and it is now for history to follow it up, as histories do, with its theories and deductions. What have we in this compressor that we have not in other compressors? It would be better to reverse the question: What do we not have in this compressor that we do have in other compressors? In the particulars which are here conspicuous by their absence are to be found the presumptive advantages of this machine over others.

For one thing—and it is not a little thing—we do not have any lubricant about this machine. Oil or grease, or any of their substitutes or disguises, are banished entirely with all the troubles they entail, and in this alone is all the backing for the device that could be desired. There is no oil to be bought.

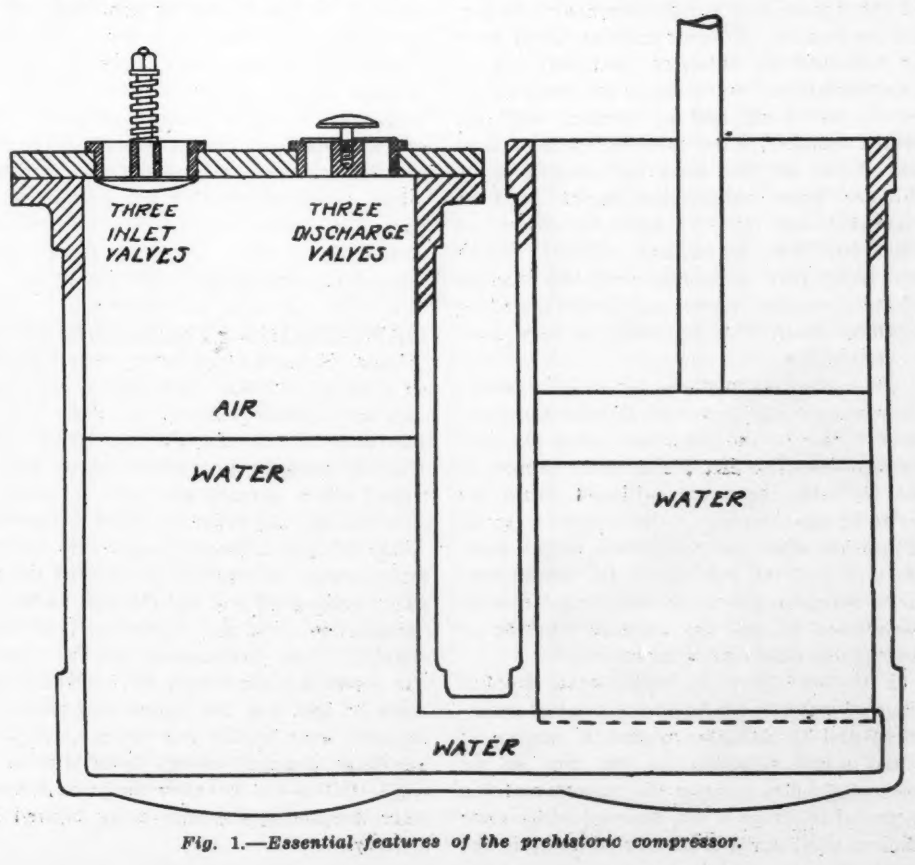


Fig. 1.—Essential features of the prehistoric compressor.

*Reprinted from "Power Plant Engineering."

no oil to be stored, no oil to be systematically dosed—even in homeopathic doses—to the machine, no oil to cling to and burn onto the cylinder and piston surfaces, no oil to stick to the valves and choke the passages, no oil fumes to mix with the air, no formation of explosive mixtures with the possibility of destructive explosions. There is no polluting of the air in any way, and it must leave the compressor as pure as when it enters. It may be inhaled without suggestion of complaint by the sandhogs in pneumatic caissons or in tunnel driving. It may come in contact with food products anywhere or be used in connection with the most delicate chemical manipulations.

It will be evident at once also that with this compressor in full operation there will be no unfilled clearance space remaining at the end of the compression stroke, and no air will remain undelivered after its compression, so that no deductions or allowances from its full operating volumetric capacity will be demanded. The water which will be driving up the air at the completion of the compression stroke will adapt itself to all irregularities of contour, all projections or depressions of surface, and a little water in excess will pass through the discharge valves and be delivered and carried along with the air. The discharge valves and seats will thus be as clean and as operatively tight as those of a water pump, and no air will have to be reckoned with as leaking back to be recompressed. The slight excess of water here spoken of will be maintained by the admission of a minute quantity of water with the intake air.

Another detail also helping to assure the complete volumetric efficiency is the temperature of the air at the beginning of the compression operation. We know that with any of the dry reciprocating compressors in use, the temperature of the air must be raised more or less—and no indicator card will tell us anything about it—in passing the heated inlet valves and ports and by contact with the heated surfaces of the cylinder, cylinder head and piston, and that the actual content of the cylinder when compression begins must be somewhat less than the apparent volume as computed from the known capacity. With our water here so omnipresent, this heating of the air cannot occur and the computed or apparent quantity of air must be very close to the reality.

The compression of the air thus in immediate contact with water all through the operation brings to our attention again the now familiar paradox that the intimate contact of the air with the water will not cause the air to be any wetter or to have more water in suspension after the completion of the compression and the cooling of the compressed air to normal temperature than if the air were compressed by any dry working machine of the familiar mechanical types.

In any case, the air will contain its full quota of water vapor up to the point of saturation, and in addition to that a surplus of actual water, probably for the time in the form of globules more or less minute, and this excess of moisture if not disposed of by some efficient separator will be carried along in the

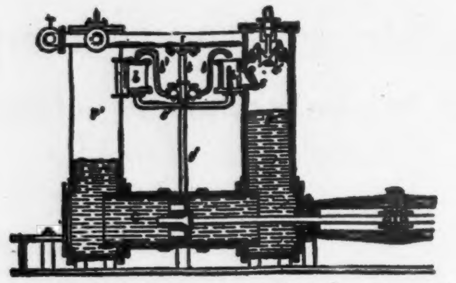


Fig. 2—Discarded water actuated compressor.

pipes and make its presence known in troublesome ways. The after-cooler and the separator, and both functions may be combined in a single apparatus, should be considered indispensable in any up-to-date compressor, and our prehistoric machine could not claim exemption.

It is not forgotten in this writing that water has been used before for the compression of air, both by direct pressure, which is necessarily extremely wasteful of power, but also as a detail of mechanically driven compressors. Figure 2 is a sketch of one of those machines which may be said to belong to the ancient history of air compression. The device shown in the present article is very different by reason of its prehistoric simplicity. While it has important practical advantages, as spoken of above, there are still objections which might be urged against it, which it is not my purpose to speak of here. The machine is certainly deserving of study as to its possibilities.

OAKITE PRIZE CONTEST

Because of the growing and widespread interest in industrial cleaning and the fact that every industry is striving for greater efficiency in all manufacturing operations so that production costs may be lowered, the Oakley Chemical Company, New York, through the medium of a new Prize Story Contest, has undertaken to act as a clearing house to bring out additional and useful ideas on every phase of cleaning and the manner and extent to which it influences quality and quantity of output. The Contest opened April 15, 1921, and closes July 1, 1921. There are 29 cash prizes offered to contestants.

DANGEROUS SYNCHONIZATION

Lieut. McReynolds, Eighth Aero Squadron, on duty at McAllen, Tex., had a remarkable experience while engaged in target practice, according to the *Air Service News Letter*. Machine guns have a synchronized gear attached which permits the pilot to shoot his guns through the propeller while in operation. While firing at a ground target with his front machine-guns several rounds entered the propeller, cutting off one end through faulty synchronization. He was forced to land immediately. Upon examination of the plane it was found that the engine had been torn loose from its bed, and the engine bed plates and supports were broken and twisted. How the lieutenant managed to get down without the engine falling out or either the plane suffering other damage or the pilot being injured is a mystery.

KEEPIN' H'UP TO DATE

By D. E. A. CHARLTON

BEEN MININ' naow a scoor o' years on h'other side an' 'ere,
'Ave tried my luck in 'ard-rock mines w'ere h'ore breaks slow but clear.
Put h'in my shif' w'ere back 'igh, an' w'ere she's loose an' slabs,
An' h'in cave groun' that won't stay put—no full swing strokes, jus' jabs.

I've worked in groun' that's pourin' wet, an' some that's dry as crust,
An' some were 'ot an' some were cold, an' h'others full o' dust.
I've single-jacked an' double-jacked, an' naws a Burleigh too,
An' mos' they types o' 'ammer drills—an' naws 'baout w'ot they'll do.

I naws some tricks in placin' sets, an' 'ow to lag a back,
An' 'ow to build a bulk'ead right to keep tha water back.
'Baout pumpin' naow, there's quite a knack—I've nawed o' chaps 'oo sent
A nummer h'eight clear h'up to top, w'en jus' a rod wuz bent.

I've shovelled h'ore h'into a chute, I've pushed a tram car too,
Poured san' h'into a h'ol mule's h'ear, an' rode a motor too.
I've woun' a win'lass roun' an' roun' in hoistin' men an' drills.
An' I'll give tha h'edge to no one in squarin' h'out for sills.

In goin' roun' o' coorse I've foun' there's ways o' doin' things
That differs 'ere an' differs there, but some ways always clings.
It's 'ard to change as time gaws h'on, an' learn a dog new tricks,
But w'en thee fin's a better way, jus' use un—see it sticks.

So, if a chap's to get a'ead an' keep h'up with tha res',
'E needs machines that do tha job; 'e's got to 'ave tha bes'
In muckin', 'oistin', 'aulin' h'ore, an' lowerin timber too
Aroun' tha stope—far from tha shaf. Now w'ot's a chap to do?

I naws, m'son, there's always ways—I've talked o' that before—
But w'ot we want is cheaper ways o' gettin h'out tha h'ore.
Naow, dam-me, son, I've foun' tha bes', in mines that's dry or moist,
Tha bes' o' h'all's tha rig they call tha Little Tugger 'Oist.

American manufacturers are planning the installation of a large typewriter factory in Austria, favoring that country rather than Czecho-Slovakia because of comparatively greater wealth of iron and cheapness of water power.

Has the Air Really Been Conquered?

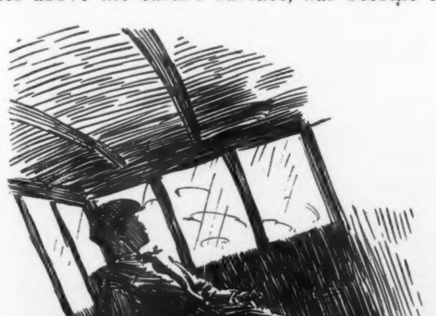
Maybe to a Goodly Extent by Compressors, but How About the Garden, or French Variety of Aerial Taxi?—Breezy Narrative of a Passenger Trip by Airplane Express from Paris to Brussels, with Vacuum Pockets, Church Spires and an Occasional Forest Intervening

By Francis Judson Tietsort

THE CONQUEST of the air, a favorite and resounding phrase, much fancied by laymen not engaged in actual dealings with the element, has taken place in the last three decades. The conquering process has been carried out in part by engineers who have seized upon the atmosphere, compressed it, and made it do their bidding in driving machinery or tools; other engineers, mechanics, scientists, experimenters and inventors from Langley and the Wright Brothers down through the whole gamut of French, English, German, Italian and Russian developers of aviation, have centered their energies on driving vehicles through the aërial belt around our terrestrial sphere in emulation of the birds.

The engineering and scientific worlds seem to have achieved up to the present a fair start in both of these fields of endeavor, but undoubtedly it is only just a "start" as regards aviation. There are many qualities yet to be discovered and utilized that are contained in the comparatively intangible sort of substance which we denote as air, or the atmosphere. Engineers now can compress it, liquefy it, blast with it, and use it for thousands of purposes as a power transmission agent in convenient form. Aviators can drive and ride through it at will. But as an element, air still is as uncharted in many respects as were those westering seas over which the gallant Columbus sailed. The scientific world is constantly experimenting with it.

The compression and the navigation of air have to-day even a common relation. Aërial navigation at great height is attained by superchargers, which make it possible for both pilot and engine to breathe and perform their functions in rarefied atmosphere. Navigation in airplanes at reasonable, or comfortable altitudes above the earth's surface, has become a



The arm rests proved useful in tense moments.

commonplace thing, more commonplace in Europe it is true, than in America, at least so far as the public is concerned. Regular aërial passenger routes are maintained between many European cities, cutting down the time of travel by such means as the railway and steamer by four-fifths, and increasing the cost of travel between two given points such as Paris and London, Paris and Brussels, or Amsterdam or Rotterdam and London, only to a fairly commensurate point, considering the big saving in time. The two-hour ride from Paris to London, across the English Channel, for instance, costs 550 francs, which at the going rate of exchange has been about $35 in American money, less than double the cost of a first class passage partly by railway and partly by steam over the iniquitous English Channel.

The Channel aërial service has been in daily operation two years, with only three or four days missed through inclement weather, and there have been only a few accidents, and but two fatal mishaps. As a whole, riding in a Paris or New York taxicab is probably more dangerous to life and limb. There are now three flights daily in each direction between London and Paris, an average of nine passengers and their hand baggage being carried each trip. Extra planes are put in service when required. There is an available regular aërial express service from Paris up to Brussels and return, and the capitals of Central and Southern Europe, Berlin, Vienna, Rome and other large centers will soon be connected by regular air "bus" service, according to plans made last autumn. Transatlantic aërial passenger service will probably be achieved in another two years.

In midsummer of last year, egged on and abetted by friends, the writer made a flight from Paris to Brussels by the regular air passenger service in a little less than two and a half hours, saving about seven hours' time. The trip afforded not a little of thrills, stimulated considerable philosophic introspection, and in general provided an experience that probably never will be forgotten. The lone passenger—there happened to be no others on that flight—made the trip in a small single-engined biplane at a pace of about 100 miles an hour.

One takes his ticket for the trip at a public *bureau* in the Rue Royale quite as though he were purchasing a railway or steamer accommodation. He must engage passage several days in advance. It is a perfectly business-like and commonplace proceeding and the French clerks in the office look just a bit bored as they make out the *billet,* enter the name and date and affix the *timbre*. The Paris-Brussels passage costs 450 francs, or about $28, including baggage and automobile to and from flying field at either end of the route.

The passenger is instructed that he may carry with him hand baggage not to exceed 30 kilos in weight, and please to be ready with his luggage at his hotel at half after seven in the morning. A light top coat is advocated in summer. A smart limousine with uniformed chauffeur calls at the hotel on the appointed moment and picks up the passenger for a run to the French Army's aviation field about five miles outside Paris, which is utilized by the commercial aërial companies by arrangement with the government authorities.

At the flying field there is usually a scene of activity even in the early morning. In the clear morning sunshine of the mid-August day of my first European *voyage aerienne* there were a dozen planes of varying size, build and engine capacity to be seen outside hangars around the outskirts of the field. Aloft about 500 metres were two army pilots cutting didoes in the air, circling about, and holding the attention of a score of aviation officers grouped about the sheds.

A blue and gray uniformed customs official came out of a nearby shed and approaching, touched his cap and inquired politely for the traveller's passport. Having shown the visa of the military police prefecture permitting one to leave France, and also having displayed the *carte de identité* now required of all aliens remaining more than a few weeks in the republic, the passenger was asked whether he had more than 2,000 francs in his possession, which at that time was the limit of currency one could take out of France. The officer courteously took my word for it that the regulations were being observed.

"Voila! Allons, monsieur," and he accepted

Then we just skimmed over the top of the spire as the clock read three minutes to ten.

a cigarette and led the way around the building to where the pilot and plane were waiting. I had not seen the machine previously and was surprised to find it was a small, well-seasoned looking biplane with a tiny, glass-enclosed cabin just forward of the pilot's seat. My preconception had been that there would be half a dozen other passengers and that we would travel in one of the big lumbering machines used in the Channel service. The pilot looked conventional in a goggled leather headpiece, leather coat, gloves and puttees. He both bowed and saluted as he seized my suitcase and thrust it in to a small compartment just abaft the engine.

The pilot set up a small ladder of iron tubing to the door of the little limousine-like body and bade me mount. The ceiling was too low to permit one to stand erect. It contained two seats facing each other, one in one corner, the other in the diagonally opposite corner, so there was plenty of footroom. The seats were upholstered in a tapestry material and had arm rests, which proved useful in tense moments. The dimensions of the cabin seemed to be about four and one-half feet long by three and one-half feet wide. The walls, where not pierced with observation windows, were lined with a figured gray satin cloth, blending in color with the seat upholstery, and were padded. There was a rug on the floor, and one noted with amusement a cut glass holder on the wall containing water and fresh flowers, such as one might find in milady's town car. Around the upper third of the cabin walls were sliding window panels, which could be opened and shut at will by the passenger. Around the bottom was another row of windows, permanently fixed, through which one could look almost straight downward toward *terra firma* when aloft, and through which this passenger glanced very seldom, it may be added, at least in the first half hour of flight.

I took the seat facing front. This position found the pilot, when he had climbed into his place, looking at the back of one's head through an open window at the rear. Before closing and fastening the small door from the outside the pilot explained that the small two-seater had been selected for the trip as there were no other bookings for that particular flight. Having frequently seen the big Handley-Page machines seating nine, and driven by two propellers and two engines, crossing between Paris and London, the present vehicle seemed tiny and not altogether too powerful.

A smiling group of a dozen stood around the plane to see us off. Just before the pilot gave the signal to a ground mechanic to start the engine, one of the two army machines which had been flying about above us, came down and made a landing, stopping perhaps 200 yards from us. One of the pneumatic tired wheels under the fuselage struck the ground first at a slight angle and under the strain was wrenched completely off and rolled swiftly across the field. This let down the under wing which hit the ground and was partly shattered at its extremity before the machine came to a full stop.

Happening right under one's nose, so to speak, it was not too happy an augury at our hop-off, but a questioning glance at the pilot brought forth a voluble verbal assurance that it was a mere nothing—absolutely nothing to which any self-confident passenger should pay the slightest heed.

Then just at this instant I happened to note gasoline dripping from the starboard tank of our own machine. It dripped down from the metal container fastened just beneath the upper wing and splashed upon the oiled fabric covering of the lower wing. I had a fleeting vision of that gas becoming ignited when we had reached mid-air, and excitedly pointed my finger at it. Once more the pilot smiled, a cool, comprehending smile, but he shook his head to indicate that this too, was of no consequence. It seems the tank had overflown in being filled, and the few cupfuls left on top the tank would soon blow off and evaporate.

He tested his controls, arranged his air map of France and Belgium in front of him, saw all was well and signaled the mechanic, who gave a turn to the propeller. The engine caught the spark and answered with a deafen-

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A general view of Paris as seen on a clear day from an airplane. The Madeleine Church, Rue de Rivoli, Rue Royale, Place de la Concorde, Tulleries Gardens, Alexander Bridge, and important public buildings are to be seen.

ing roar, kicking up puffs of dust behind us. The spectators waved their caps as we started to move. The pilot gave his engine more gas and we ran on the ground a hundred yards or more; then with a light lurch we left the solid-looking greensward and started upward, gaining height fast. The passenger saw below the flying field, the crippled plane, the cap-waving spectators, and was up at the height of a Woolworth building almost before realization came that we were off for Brussels. The passenger also noted another curious phenomenon. His legs were stretched out taut and rigid ahead of him, seeking a footrest for a brace, and his hands were involuntarily clenching the arms of the seat as though he were supporting himself in mid-air by main strength.

Gradually the muscle tension was relaxed. For the moment that it lasted it was similar to the sensation one has in bracing his feet in the front of an automobile when the chauffeur is applying the brakes to prevent an imminent collision. Everybody has had that trying and futile sensation at some time.

The towers of Notre Dame in Paris could now be seen in the sunlight and the lace-like steel fabric of the Eiffel Tower loomed up at a distance of possibly eight miles. We headed northward and could see the silver ribbon of the Seine, the bridges, and the trees of Paris parks, softened down to a meadow hue. The beauty of the swiftly shifting scene below soon dispelled the initial nervousness and one began to breathe more regularly. In the first fifteen minutes it became a matter of pride with the passenger, who fancied the eyes of the pilot were boring through his back, reading his very thoughts and interpreting his sensations, to appear as *blasé* and accustomed to this flying business as though it were a mere everyday experience, or danger, such as conveyance in a Parisian taxi. One thought of trying the effect of a yawn on the pilot, but that seemed carrying the perfectly-at-home idea a bit too far. That would probably be correctly interpreted as being ridiculous, and if there is one thing that a passenger hates to do in an airplane, it is to appear ridiculous. If the reader has been up in an airplane, he will understand this perfectly.

The one preventative to a complete sense of taking one's ease in this particular sky taxi on that day was that occasionally there was a disconcerting jerk to interrupt our flight. I tried for some time to analyze it; at first I thought it was some of the engine's cylinders missing, but that was not the cause. It was the element in which we were navigating—the air —or rather a lack of it, for we were striking little whirling pockets of vacuum. When we struck such a "pocket" there occurred a swift drop of the plane which struck a chord somewhere in one's internal centre of gravity. The same feeling is experienced by passengers in a New York skyscraper elevator when without warning it drops like a shot for a floor or two. There is no bump at the bottom of the drop in an airplane, however; the plane goes constantly ahead, even though it has dropped out of the pocket back to solid air again.

The views of *La Belle France* below were so attractive and the pilot's face remained so

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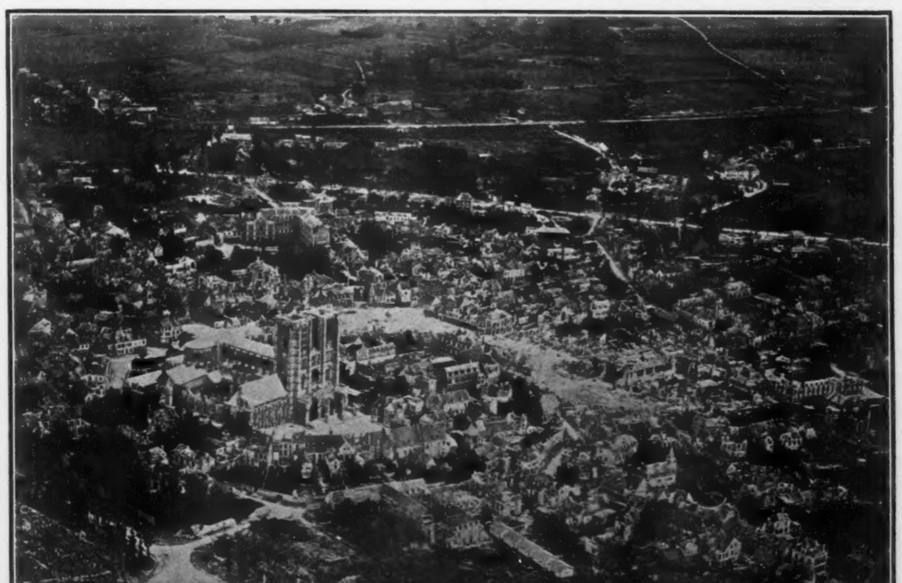
Another striking aerial photograph of the beautiful French capital, showing the Arch of Triumph (where rests the Unknown Poilu of France) built by Napoleon's command, and the hub-like centre for urban thoroughfares that are among the most famous in the world, including the Champs Elysees, the Avenue Friedland, Bois de Boulogne and others which are easily recognizable.

immobile when glimpsed that after a half-hour of these cushioned jerks the passenger became inured to them. The truth was we were headed into a gale of wind which was blowing great guns at our altitude of 1,500 feet. In another fifteen minutes it brought a rainstorm and we dived into great banks of angry-looking clouds, rain pelting the cabin windows with the noise and force of hailstones. The temperature dropped ten degrees. Rising to a half standing position I slipped into a cloth raincoat for more warmth and closed my sliding window on the port side until there was only a two-inch aperture for ventilation. The wind howled through this opening like a demon.

The pilot suddenly applied more gas, shifted controls and climbed. In five minutes dazzling sunshine beat through upon us again and we surveyed at a height of a mile the weird spectacle of a seemingly boundless sea of soft white clouds, far beneath us. Above was a sapphire sky and the flaming sun; below was nothing but a billowing plain of fleeciest eider down, looking tempting enough to fall into for repose. It made one think whimsically



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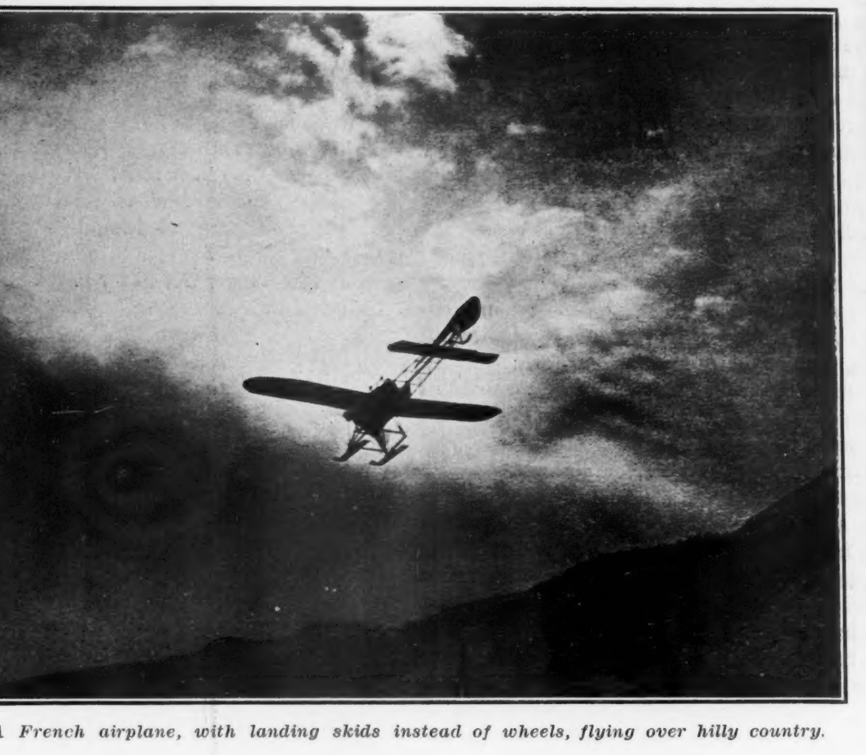
This aerial view of historic Noyon shows the debris of wrecked buildings and the work of restoration, including work on the Cathedral, which greatly resembles the Rheims edifice.

of what a perfect setting it would be for Rubens' cherubim and seraphim seated on heavenly cloud banks!

For more than half an hour we flew at this great height, as registered by the altimeter, far above the vapor masses that were dropping their moisture on French farms. I chanced to look quickly about at the pilot. He was steering only by compass, of course, but was now pulling out his land map again. I was soon to know the reason. Without checking his engine, apparently, he pulled at some controls and we began to shoot earthward at a truly dizzying and sickening pace. He had determined to get down beneath the clouds again to obtain a view of what lay below in order to take bearings. Travelling at the pace we were going, and steering only by compass, a slight miscalculation, or the effect of a side thrust from the head wind might have carried us out to sea, or on the other hand taken us over Germany. The pilot realized these things fully, and although conversation was out of the question, I also realized them immediately and poignantly. For a second or two I was sure that man had not yet achieved a complete conquest of the air!



A French airplane, with landing skids instead of wheels, flying over hilly country.

This conviction became certainty when in less time than it takes to set down these words we flashed down through the rain and out of the clouds and saw the earth directly beneath, and we were descending toward it at a frightful pace. I am confident that the solid ground, which offers little resiliency for an oncoming airplane, was not more than 350 or 400 feet away! The pilot saw it simultaneously and stepping on all the gas he had and tilting his planes he shot us upward again with a roar and a magnificent swoop.

There was a village below us. A woman was leading a cow along a narrow street. Both she and the cow stopped in their tracks and looked up at us. An automobile stopped too and the driver waved his hand. Our perilous nearness was only part of a Roman holiday to him. Men and women and children gazed at us, open-mouthed, arms akimbo.

My cardiac pumping station seemed to stop functioning; even breathing ceased. I thought of my family, my life insurance and of my past misdeeds in a naughty world. I made high resolutions for the future, provisionally. There came a flashing jumbled panorama of thoughts—a contraction of every muscle to the snapping point.

Then we just skimmed over the top of the spire of the inevitable village church—I could see the clock a few yards away and it read three minutes to ten—and the margin between the underbody of the plane and the church spire might have been three or four feet! Ahead of us loomed the brow of a hill and a wood. We just missed the tops of the trees before the upward pull of the engine and of the planes began strongly to be asserted. We were at last safe and out of that tight squeak. This all occupied a few seconds as time is measured by chronometers, but it seemed years!

Once up again a thousand feet and just beneath the now thinning and scattering clouds, for the rain had ceased, I looked around reproachfully at the pilot. He was reading his map, but glanced up to smile at me as though it were all in his day's work. My only consolation was that he had been as near to dangling by the coat tails from the top of a church steeple as I had been. One is merely an impotent infant when in the hands of an air pilot and chaps of this ilk seem to *know* it.

© Kadel & Herbert.

Air airplane flying over the Alps on the French-Swiss frontier.

The flying weather now quickly improved and the storm passed, though we could see it rumbling away southeastward, with occasional lightning flashes in the black clouds. The sun once more warmed us. We darted above a good-sized town, crossed a river, and then we perceived a great expanse of forest ahead. The pilot began to climb again at sight of the forest. We crosssed the forest in ten or twelve minutes at a height of a mile and a quarter. I did not at first grasp the reason for our lofty flight at this point, but when the reason did dawn upon me it was sound and convincing enough, but not entirely reassuring since it involved the element of safety margin in an airplane engine.

A forest is a notoriously bad place in which to effect a landing if an engine goes dead, and we had only one engine, so the pilot gave us a fighting chance. A machine can volplane laterally downward seven miles for every mile of height it is in the air. At our height we could have slithered earthward for eight or nine miles possibly had the engine stopped. Luckily it didn't. I am still grateful.

Beyond the forest we came to the battlefields of France. From the air they presented a marvelous panorama. Entire trench systems and countless shell holes were still plainly visible. Shattered buildings, thousands of tons of war's debris, great heaps of barbed wire entanglements, piles of corrugated galvanized iron, shell cases, overturned tanks, gun carriages and smashed artillery were below us

along our route. Workmen had piled up vast quantities of materials that could be salvaged. Red roofs of tile indicated reparation work. But as ruined city and town and village passed beneath in swift review it seemed as though rehabilitation must be an almost hopeless task.

Still new factories, new railway stations and rising rows of workmen's cottages caught the eye here and there and indicated what a good fight France was making against chaos and ruin. Everywhere men and women and children and beasts of the field were tilling the soil beside the remains of war's wrack and this was an inspiriting sign. The spectacle of devastated France from the air was one long to remain in memory—it taught one more in one swift lesson than years of reading concerning what the war brought in its wake. The saddest things to see were the thousands on thousands of white crosses telling their mute story on every hand.

We finally passed out of France and over the line into Belgium, instantly recognizable. King Albert's kingdom has its own stamp and impress and it is pronounced from a point of aërial vantage. It is probably the most intensively cultivated country, in an agricultural sense, in the world. Last summer it had a great farming boom; every square inch of arable land was under the plow and the yield, as figures afterward attested, was great and satisfying to that honest and thrifty people. Time was growing short now. We neared the journey's end.

Passing over two smaller cities we finally caught sight of the large and beautiful city of Brussels glistening in the shafts of light. It presented a majestic picture with its fine and more modern buildings and its ancient structures, seven or eight centuries old, as we traversed its entire breadth.

A Belgian Army plane headed up toward us. It contained a pilot and observer, and the latter as his plane whipped by, not more than a hundred yards' distant, waved us a greeting. Ahead, on the far side of the city, was to be seen the Belgian Army's aviation field. We pointed for it, wheeled about and came down like a gliding seagull to its smooth, velvety-looking turf. There was a moment of dread and doubt about landing, but it quickly ended. The roar of the motor ceased, there was a delightful interval of ease and relaxation, and then there came a gentle touch and rebound as the landing wheels touched the ground. Then we actually were in contact, and slid along some yards. Before we actually stopped the pilot again turned on his power and "taxied" us on the turf to the point from which he was to make his return journey to Paris.

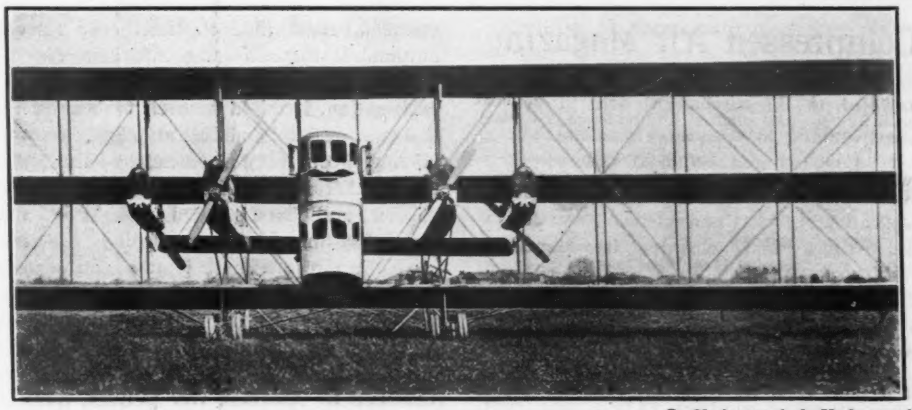
He hopped out, put up the little iron ladder, opened the door and said, inevitably:

"Voila, monsieur!"

One didn't know whether to be sorry or glad to put his feet once more on *terra firma.* It had been a moving, thrilling, breezy and deafening experience. On the latter head, hearing was difficult for 36 hours afterward.

The pilot shook my hand, murmured a French politeness and leading me to the little Belgian customs office on the field, saluted and took his leave. I noted that he joined a group of the Belgian aviators to whom he recounted animatedly the adventure of nearly hitting the village church spire and trees on the hill, so it *had* made a dent in his apparently imperturbable self!

The Belgian customs officer asked whether I had more than a few cigarettes, clapped an inspection stamp on my unopened suitcase, wished me a very *bon jour* and disappeared. Another limousine awaited me. It whisked me to the Metropole Hotel in town, which had been filled by German officers and their wives during the occupation throughout the war, and two minutes after appearing at the desk of the reception clerk, business friends notified by telegraph of my departure from Paris were greeting me. The trip had been made absolutely on schedule time, including automobile conveyance at each end of the route, but one still felt rather "up in the air."



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A huge Caproni plane with five motors aggregating 2,000 horsepower used for long distance passenger flights.

© Underwood & Underwood.

Zeppelin L-72 flying over Lyons, France, after its surrender to the French Government under the Treaty of Versailles. Our photograph was taken from an accompanying French plane. Hundreds of thousands of people watched this dirigible fly over Paris.

Stocks of crude oil in the Russian fields in August, 1919, amounted to approximately 25,000,000 barrels, according to official report. Oil men in this country in touch with oil conditions in Russia state that only a small amount of oil is coming out of Russia at the present time. However, because of conditions in Russia due to labor, etc. this is probably the reason why larger quantities are not received in other countries. The Bolsheviki have not been successful in developing the oil fields and oil men in New York believe it improbable that they have been able to keep production ahead of their own needs, if up to them.

The first annual meeting of the International Chamber of Commerce will be held in London, June 27 to July 2, 1921.

Compressed Air Magazine

—Founded 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:
Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

Chicago Office: Sears & Irving, Representatives Peoples Gas Building

Business Office for the British Isles:
J. F. Atkinson, Representative
No. 31, Essex Street, Strand, London, W. C. 2

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries, $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

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EDITORIALS

COMPRESSED AIR ESSENTIAL FOR BATTLESHIP EFFICIENCY

THAT THE fighting ships of the maritime nations are in a state of flux is undeniably true; and however they may be modeled and made to operate in the years to come it is inevitable that the capital ship of some sort will be the type by which a nation's strength upon the sea will be measured.

At the present moment, when most countries are clamoring for peace, the question still persists, What will the capital ship of the near future be? And this question is engaging the attention of naval men both here and abroad and likewise provoking discussion among a goodly number of the general public.

Enthusiasts that visualize the potentialities of bombing air craft do not hesitate to say that flying flotillas will prove more than a match for the relatively sluggish, steel-clad superdreadnought. Yet how many of these self-appointed critics of the big fighting ship recall that the doom of the heavily-armored units of the battle line has been similarly sounded, from time to time, ever since the automobile torpedo came into being?

In order that we may not be misled through anticipation, it might be well to bear in mind that the aerial bomb is, in effect, a torpedo moving through the air instead of through the water; that it lacks inherent powers of propulsion; and that its speed in flight is but the cumulative impulse of gravitation. In several ways the aircraft bomb is far inferior to the automobile torpedo. And what did the latter weapon achieve during that crucial contest off the shores of Jutland?

It is a matter of record—the figures being furnished by Admiral von Scheer, himself—that the Teutons launched 107 torpedoes at the British squadrons, and we know that the battleship *Marlborough* was the only one hit. Even so, and while seriously hurt, that vessel was still able to remain in action for a considerable while thereafter. But, on the other hand, what is the story of the damage done by gunfire? See what happened to certain of the big craft of the British forces when German armor-piercing shell found their targets.

On that fateful 30th of May, five years ago, H. M. S. *Lion,* at a distance of 18,000 yards, was hit twice within three minutes by heavy projectiles and by the narrowest of margins escaped instant annihilation. A few moments later H. M. S. *Indefatigable* was sent to the bottom by two consecutive salvos from the *Von der Tann.* Less than 30 minutes afterwards, the battle cruiser *Queen Mary* was hammered by a German broadside and blew up and vanished completely in a few seconds. When the battle was underway something like two and a half hours, H. M. S. *Invincible* became the target for the *Derfflinger,* and once more a group of armor-piercing missiles found their mark and caused the ship to disappear in smoke and flame. Gunfire also destroyed H. M. S. *Defense, Black Prince, Warrior,* and a number of the lesser vessels of the British squadrons; and the damage inflicted, in turn, upon the German fleet, was entirely due to the effective work of England's naval rifles.

In view of what the gun has done, we may well be satisfied with the latest of our capital ships as typified by the U. S. S. *Tennessee.* This splendid fighting machine was really the first of our superdreadnoughts to be designed for steam-electric propulsion, although actually following the U. S. S. *New Mexico,* laid down nearly two years earlier and originally planned for geared-turbine drive. The *Tennessee* is somewhat larger than the *New Mexico,* and in some particulars a better and a more formidable craft. From bow to stern she has an overall length of 624 feet, a maximum beam slightly in excess of 97 feet, and, when full laden, she draws 31 feet of water. Her displacement or deadweight totals 33,190 tons. Tucked away in her bowels is an oil-fired steam plant capable of developing 30,000 horse-power, and this energy, when applied to her four big propellers, is able to impel the giant ship against tumbling seas at the rate of 21 knots an hour.

The steam-electric drive represents the wedding of two prime movers peculiarly fitted to utilize each other's distinctive qualities when functioning most efficiently. That is to say, the steam turbine can be operated most economically at its highest speed, while the dynamo directly connected and revolving at the same rate, can be patterned to convert this energy into electric current and to distribute it to functioning motors wherever these machines are placed aboard the vessel. A network of energizing nerves is thus substituted for a circulatory system of steam pipes that is subject to losses through leakage and radiation, and which requires holes in bulkheads likely to open ways for invading water just when the safety of the craft and those aboard hinged upon the steel walls holding up under stress.

In her defensive and offensive features, the *Tennessee* is a better ship than any of the capital craft upon which Great Britain pinned her faith at Jutland. Her main armor belt is of fourteen-inch plates of hardened steel, so disposed as to shelter magazines, boilers, engines, control room, etc. To safeguard her vitals from plunging fire she is provided with two armored decks of process steel. Heavy steel bulkheads also stand athwart the path of a possible enemy's raking fire. The ship's under-water defense rests primarily upon the disposition of process-steel bulkheads and the honeycombing of the structure contiguous to the sides and bilges so that the white-hot gases of a torpedo or mine may be sapped of their strength by giving them a chance to expand and to chill while confining their destructive action to comparatively narrow limits. And then, there lies in reserve a further corrective agency in the form of compressed air, which can be counted upon to check the flow of the intrusive sea.

The *Tennessee's* main battery is composed of twelve fourteen-inch guns mounted in four heavily armored turrets. These weapons can be fired every 30 seconds; and each gun hurls a 1,400-pound projectile. At maximum elevation of the rifle the shell has a range of fifteen miles. Starting with a muzzle velocity of 2,800 feet a second, the missile can speed toward its mark with amazing accuracy, can bore its way through walls of steel, and then burst with the shattering might of 80-odd pounds of high explosive. Again, compressed air is a prime aid in making it possible for these weapons to work as they do.

And then, besides guns of lesser caliber for the repelling of destroyers, submarines, air craft, etc., this magnificent battleship is equipped with submerged tubes for the launching of 21-inch torpedoes. These "steel babies" have a range of 13,500 yards, and each of them carries in its warhead more than 300 pounds of T. N. T. Compressed air impels the torpedoes from the tubes, and compressed air also sends these instruments of destruction speeding on their way.

But the capital ship finds still other services for compressed air to perform. It is used to clear boiler tubes, to clean the all-important dynamos and motors, to operate pneumatic tools, to atomize the liquid fuel in the galleys where the food for the numerous personnel is cooked; and air compressors dominate the **refrigerating equipment which produces ice,**

chills the cold storage compartments filled with toothsome provender, and plays its part in the providing of an abundance of fresh and potable water. Finally, the compressor supplies the cooling medium that keeps the temperature of the magazines, laden with their tons and tons of explosives, low enough to prevent the disintegration of the powder or the genesis of spontaneous combustion.

STRIKE INSURANCE, A NEW ASSET IN BUSINESS

YOU CARRY fire insurance? Yes—but although fire insurance companies are indefatigable in their efforts to prevent a fire occurring on your premises and are responsible for many of the building law reforms that make for minimizing fire risks, they cannot guarantee you against its occurrence—only indemnity against loss. Life and accident insurance companies do still less. They have no control whatever over your manner of living once your policy is taken out. You may violate all the rules of health and may constantly place yourself in positions that invite danger to life and limb, they can only compensate you, or your heirs, in case of accident or death—no guarantee goes with the policy against such eventualities.

A new form of insurance has come into existence—strike insurance—and, although it carries with it no absolute guarantee against the occurrence of a strike in your factory, it comes as near to it, or rather it will come near it when the full significance of the service is understood and generally adopted, because it will operate to prevent strikes by removing the incentive.

The strike is the coercive weapon of the labor union. It wields this weapon because it knows that the employer must operate his plant in order to make money. Being protected in a large measure from monetary loss by its strike benefit fund it is able to withstand indefinitely while watching its employer, not so protected, lose money. But if labor knew that its employer was fully protected against loss by reason of its strike—that a strong insurance company was under contract to pay him the normal profits of his business in case of disturbance in his plant, and to continue such payments indefinitely, it is reasonable to expect that labor would think twice before "walking out." This is the theory of strike insurance and it is not all theory for its efficacy has been proven in other countries, and is being proved here.

Pioneering in this line—at least so far as the United States is concerned—is the Employer's Mutual Insurance and Service Company of Baltimore, Maryland. Being convinced of the efficacy of such methods as a solution of the labor problem, its proponents entered upon a careful study of strike statistics and labor troubles, and, after five years of investigation covering experiences of the past 39 years, opened its doors for business last year. If the service rendered accomplishes what it is intended to accomplish, it should be as indispensable to plant owners as fire, workmen's compensation or other forms of insurance.

Strikes are a normal risk in business and it is to be wondered at that some form of insurance against loss by reason of them has not before been inaugurated. Statisticians tell us that the strike menace is fifteen times as great as that of fire, and that strikes are responsible for an economic waste of five billion dollars a year; they tell us that, in the six months between January and June, 1920, (inclusive) there were eight million men and women engaged in strikes the world over, involving a loss of 115 million working days, and that one million of these strikes, and eleven million of these days work lost were in the United States. They tell us that, in 1881, less than 50 thousand workers were members of the American Federation of Labor; that, by 1895, this number had increased to 1,700,000, and that, at the present time, their membership reaches four million or more.

The prototype of strike insurance is found in Germany. Inaugurated in 1904, by 1913, 63.7 per cent. of employers, employees and manufacturers were covered by such insurance which resulted in curtailing the number and limiting the duration of strikes 40 per cent. In five of the largest industries of Germany, more than 90 per cent. were covered by strike insurance in 1913. It is easy to see what it would mean to the industry of the United States if the annual waste of five billion dollars were reduced 40 per cent. as in Germany. Two billion dollars saved each year would run the national government; in normal times this sum would solve the housing problem, or it would place the disturbed railroad situation on a firm financial footing. It is the hope of the Baltimore company to equal or better Germany's results.

Nobody questions the right of labor to organize for its own protection. Nobody should question the right of employers of labor to protect themselves in legitimate ways against loss by reason of unwarranted demands. It should be understood, however, that strike insurance is not conceived and practiced in any mere spirit of hostility to labor any more than a labor union would admit its strike benefits to members to be meant as acts of hostility to employers. On the contrary by ameliorating the conditions of employment so as to lessen provocation to strikes, it will serve the welfare of labor as directly and efficiently as that of capital. It is really calculated to provide a new asset for industry, and it is a noticeable fact that strike insurance already has, as a matter of record, prevented 76 per cent. by the strikes by which the insured employers were threatened. A veritable deterrent, surely, and one to be seriously considered, since comparative calculations by experts indicate the probability of more than 110,000 strikes during the next five years unless employers meet the situation with preventive measures.

It is a matter of history that heavy insurance rates, high because of great hazard, have resulted in the installation of improvements and safeguards to prevent loss. By the scientific application of like principles the Baltimore company hopes to check strike losses through improving and removing the conditions which cause them.

The plan of operation is that the insurance company indemnifies its members against actual loss of fixed charges and net profits caused by partial or total stoppage of production through strike or walk-out of all or part of its employees.

The amount of insurance required by a given plant is the sum of its estimated fixed charges and net profits for the ensuing year, the object being to cover 80 per cent. thereof. For example:

Estimated Fixed Charges....	$100,000
Estimated Net Profits........	200,000
	$300,000
	80 P.C.
300 Working Days...........	$240,000
Per Diem Indemnity.........	800

The Employers Mutual is the only company of its kind in the United States and, although it has been in business but a short time (since May, 1920) it has written a large amount of business and also has settled many indemnity claims. Its activities are, of course, attacked by the labor unions which seek to limit its sphere of usefulness. In all controversies of this kind, however, it is popular opinion that, in the end, governs and, since labor is so intensively organized, public opinion cannot fail to accord the employer a like privilege.

"PNEUMATIZE" NEW WORD NOT IN DICTIONARY

THIS WORD "pneumatize" has not got into the dictionary yet but is on its way there, having already found its place and demonstrated its use and applicability in enterprising advertising pages. The word while not wearing the simplest English style is entirely self-explanatory and may be used in all the moods and tenses, but is at its best in the imperative.

Pneumatize your thinking habits, and then your plans and methods.

Pneumatize your tools, your works, your men; and pneumatization will carry with it high suggestion of industrial efficiency.—*R.*

A FORGOTTEN SATIRE ON PURE SCIENCE

ALTHOUGH many scientists are familiar with CARLYLE's satirical remarks about science in the first several paragraphs of his famous *Sartor Resartus,* few know of a play of the Restoration period called *The Virtuoso* which poked fun at the scientists of the Royal Society. This play was written in 1676 by THOMAS SHADWELL, later poet-laureate under WILLIAM and MARY. Like most of the plays of the Restoration period *The Virtuoso* has a good deal of rough humor and illustrates the bluff spirit of the times. Modern science was then in its swaddling clothes, and was jeered at by superior gentlemen like SHADWELL. It was the period when BOYLE was investigating the atmosphere to find what air really is, when NEWTON was beginning his career as perhaps the greatest mathematician and physicist of all time, and when NAPIER's logarithms were becoming known.

The virtuoso of the play is called Sir *Nicholas Gimcrack,* which name is somewhat

of a satire in itself. Another of the characters is Sir *Formal Trifle*, a name that should appeal to anyone who has attended a faculty meeting of a modern college. In the second act a visitor comes to the home of Sir *Nicholas*. Lady *Gimcrack* tells him that her husband is learning to swim. The visitor asks, "Is there any water hereabouts, Madam?"

Lady Gimcrack: He does not learn to swim in the water, sir."

Bruce: "Not in the water, Madam! How then?"

Lady Gimcrack: "In his laboratory, a spacious room, where all his instruments and fine knick-knacks are. . . . He has a frog in a bowl of water, tied with a packthread by his loins; which packthread Sir *Nicholas* holds in his teeth, lying upon his belly on a table; and as the frog strikes, he strikes; and his swimming-master stands by, to tell him when he does well or ill."

The next scene discovers Sir *Nicholas* learning to swim upon a table; Sir *Formal* and the swimming-master stand by. Sir *Formal* tells the swimmer that in a short time not a frog breathing will exceed him, "in the art, shall I say, or rather nature of swimming." The swimming-master remarks, "Well struck, Sir *Nicholas;* that was as well swum as any man in England. Observe the frog . . ." etc.

Longvil: "Have you ever tried in the water, Sir?"

Sir Nicholas: "No, sir; but I swim most exquisitely on the land."

Bruce: "Do you intend to practice in the water, sir?"

Sir Nicholas: "Never, sir; I hate the water, I never come upon the water, sir."

Longvil: "Then there will be no use of swimming."

Sir Nicholas: "I content myself with the speculative part of swimming, I care not for the practice. I seldom bring anything to use; 'tis not my way. Knowledge is my ultimate end."

Bruce: "You have reason, sir; knowledge is like virtue, its own reward."

Sir Formal: "To study for use is base and mercenary, below the serene and quiet temper of a sedate philosopher."

Lady *Gimcrack* tires of her too-scientific husband; she says that "Sir *Nicholas* is a fine solitary philosophical person. But my nature more affects the vigorous gaiety and jollity of youth than the fruitless speculations of age." Later when misfortunes befall the unlucky virtuoso, she deserts him, and threatens, if he makes trouble, to send love letters that he has received from other women to Gresham College. Says she to her hapless husband: "You were all the while bottling of air, studying spiders and glow-worms, stinking filth and rotten wood."

In the last act a mob of weavers storm the house, crying that Sir *Nicholas* and Sir *Formal* invented the engine-loom to the confusion of ribbon-weavers. Sir *Formal* tries his stilted oratory upon the rabble, but they say that though his tongue is well hung they cannot understand "his stuff." Sir *Nicholas* then addresses them:

"Hear me, gentlemen. I never invented an engine in my life; as God shall save me, you do me wrong. I never invented so much as an engine to pare cream-cheese with. We virtuosos never find out anything of use; 'tis not our way." The two escape, but Sir *Nicholas'* estates in the country are seized by people associated with him in his experiments, and the poor man ends with no friends and no possessions (as many an unfortunate inventor has done). He sighs: "That I should know men no better! I would I had studied mankind, instead of spiders and insects."

While on the subject of satires upon science, it might be interesting to recall the caustic words with which THOMAS CARLYLE began his *Sartor Resartus*. Said he (writing in 1830 at his lonely moorland farm in Scotland): "Considering our advanced state of culture, and how the Torch of Science has now been brandished and borne about, with more or less effect, for five thousand years and upwards; how, in these times especially, not only the torch still burns, and perhaps more fiercely than ever, but innumerable rush-lights, and sulphur-matches, kindled thereat, are also glancing in every direction, so that not the smallest cranny or doghole in Nature or Art can remain unilluminated,—it might strike the reflective mind with some surprise that hitherto little or nothing of a fundamental character, whether in the way of philosophy or history, has been written on the subject of Clothes."

CARLYLE continued in his characteristic, cranky way: "Our Theory of Gravitation is as good as perfect: LAGRANGE, it is well known, has proved that the planetary system, on this scheme, will endure forever; LAPLACE, still more cunningly, even guesses that it could not have been made on any other scheme. Whereby, at least, our nautical logbooks can be better kept; and water-transport of all kinds has grown more commodious. Of geology and geognosy we know enough; what with the labours of our WERNERS and HUTTONS, what with the ardent genius of their disciples, it has come about that now, to many a Royal Society, the creation of a world is little more mysterious than the cooking of a dumpling; concerning which last, indeed, there have been minds to whom the question, *How the Apples were got in* presented difficulties. Why mention our disquisitions on the Social Contract, on the Standard of Taste, on the Migrations of the Herring? Then, have we not a Doctrine of Rent, a Theory of Value; Philosophies of Language, of History, of Pottery, of Apparitions, of Intoxicating Liquors? Man's whole life and environment have been laid open and elucidated; scarcely a fragment or fibre of his soul, body, and possessions, but has been probed, dissected, distilled, dessicated, and scientifically decomposed: our spiritual faculties, of which it appears there are not a few, have their STEWARTS, COUSINS, ROYER COLLARDS: every cellular, vascular, muscular tissue glories in its LAWRENCES, MAGENDIES, BICHATS."

Both SHADWELL and CARLYLE, it is apparent, picked out vulnerable places to attack. Though they exaggerated, some of their points are as applicable to-day as they were when written. Perhaps it is true that science, difficult as its course often is, still would profit by occasional satires to indicate where it is foolish and overdone.—*P. B. M.*

DRASTIC METRIC LAWS PROPOSED

BILLS HAVE been introduced in both Houses of Congress proposing to fix the metric system as the single National standard for weights and measures. These bills specifically provide that "from and after ten years no person shall do or offer to attempt to do any of the following acts, by weights and measures, in or according to any other system than the metric system of weights and measures, namely: Sell any goods, wares, or merchandise except for export as provided in section 12; charge or collect for the carriage or transportation of any goods, wares, or merchandise; charge or collect from or pay or reimburse any other person for work or labor which has been or is to be performed or done. . . ."

It is further provided that "from and after four years no person shall manufacture or make for himself for use, or purchase for use any weight or measure or weighing device constructed, marked, or graduated in any other system than the metric system of weights and measures; that from and after ten years no person shall use or attempt to use any other system than the metric system of weights and measures; that from and after two years no person shall manufacture or pack, offer for sale or sell any goods in package form, which are required by law to be marked in terms of weights and measures, unless they be marked in or according to the metric system of weights and measures; that no later than ten years all postage excises, duties and customs charged or collected by weights or measure shall be charged or collected in or according to the metric system of weights and measures; that rules and regulations for the enforcement of this act shall be made and promulgated by the Secretary of Commerce."

This is a matter of the greatest importance, bearing heavily upon all industries and activities. Only criminal negligence can permit such "law-making" to sweep along unobstructed.

OUR STEADFAST FOUNDATION

We quote the following from an editorial in the *N. Y. Times*: "We change our party majorities, we install a new Administration, the men in power withdraw to private stations and new men take their places, but look, the flag upon the Capitol, upon the White House all over the Union, is the same. That flag is the symbol of freedom, of truth and justice and right, of principles as unchanging as the allegiance to them of the American people. Administrations are changed for reasons of temporary moment; in things of faith and conscience we change not at all."

The government of the United States expects to locate some place in the southwest a great national hospital, to cost approximately $2,500,000.

South America is figuring largely in Lancashire plans to create new sources of supply. Argentina is planting 59,000 acres of cotton as against 33,000 last year.

MOLASSES AND ALCOHOL

The Louisiana Planter says that in the manufacture of sugar there is produced by a by-product, molasses, in large quantities—five gallons or more per short ton of cane handled. The market value of molasses depends upon the facilities for converting it into alcohol and the latter's by-products.

Molasses is an ideally perfect medium for production of an alcohol ferment—unlike all the other products of a starch base that require an expensive preparation to reach a sugar fermenting state. Molasses requires only the addition of a diluting medium and a fermenting medium, as yeast, to obtain the alcoholic condition. There does not exist a medium from which alcohol can be produced so cheaply as from molasses, nor one to be had in such an abundance at a low cost.

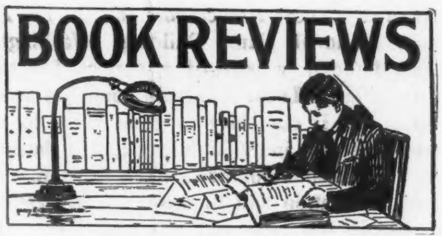
A bushel of corn costing now 70 cents will produce two and one-fourth gallons of alcohol. It will require five and seven-tenths gallons of molasses to produce two and one-fourth gallons of alcohol, at five cents per gallon equals 28.5 cents as against 70 cents for corn.

AN ENGINEER—SCULPTOR

Mr. Peter N. Nissen, whose reputation as a mining engineer and as the inventor of the Nissen stamp is well known, and who achieved distinction in the Great War as lieutenant-colonel of the Royal Engineers and the originator of the "Nissen hut" for troops, has designed and modeled a series of figures that are to form the group of statuary of the war memorial of the Institution of Mining and Metallurgy to those of its members who sacrificed themselves for the Great Cause. The roll of honor contains the names of 119 men, for whose devotion to duty and country, Mr. Nissen's statuette will form an imperishable record.

JOHANNESBURG MINE SHAFT 7,000 FEET DEEP

Deep mining on the Rand, the great gold reef neighboring Johannesburg, South Africa, has been in practice for many years. At the City Deep Mine, says *Popular Mechanics*, there were two shafts, 3,300 feet and 4,000 feet deep, respectively, but to exploit the mine thoroughly it was found that a much greater depth would be needed, and, therefore, it has been decided to sink a shaft of circular section to a depth of 7,000 feet. The shaft will have a diameter of twenty feet, and will be fitted all the way down, at ten-foot intervals, with concrete rings, each eighteen inches deep by fifteen inches wide, to provide fastenings for the necessary guides, pipes, and cables, and also for any lining that may be needed in the future. The capacity will be 2,000 tons of ore per 24-hour day; and the cage operating in it will be five feet three inches by fifteen feet six inches, with two decks, and will be made entirely of steel. There is already in operation at the mine a double-inlet sirocco fan, twelve feet ten inches in diameter, with a capacity of 420,000 cubic feet a minute, and it is thought that this will be able to care for the new and old workings of the mine.



OCEAN STEAMSHIP TRAFFIC MANAGEMENT, by GROVER G. HUEBNER, PhD., professor of Transportation and Commerce in the University of Pennsylvania. Illustrated with half tones, maps and diagrams; 273 pp; price, $3.50, net. New York: D. Appleton & Company.

THE PURPOSE of this book is to present in systematic order the particular facts, forms, practices, functions and principles which the men engaged in or contemplating employment in the shipping business should know with respect to steamship traffic management. The text is divided into three parts. Part I deals with the traffic organization of ocean shipping, and the organization and functions of the various types of ocean services and traffic agencies are classified and defined. In Part II, ocean shipping documents—their contents, forms and uses—are described, and many are reproduced. Part III deals with ocean freight rates and regulation and contains chapters on ocean freight classification and rate tariffs, ocean rate-making, and the regulation of steamship services and rates by the Government.

This book was written with the view of it being read by individual students conducting their studies without guidance and also with the expectation that it would prove useful as a class text book. Doubtless it will be accepted by colleges, technical institutes and high schools teaching courses in foreign trade, shipping and ocean transportation.

THE MAKING, SHAPING AND TREATING OF STEEL, by J. M. CAMP and C. B. FRANCES. Illustrated and indexed, bound in limp leather, second edition; 614 pp. Published by the Carnegie Steel Co., Pittsburgh, Pa.

THIS BOOK has been written especially for the non-technical employees of the Carnegie Steel Company and others, who, seeking self-instruction may desire to secure in the shortest time possible a general knowledge of the metallurgy of iron and steel.

The volume is the result of several years experience in attempting to teach the metallurgy of steel to salesmen and other non-technical employees, we are told in the preface. The method pursued from the beginning was that of taking the students into the mill where they were able to collect, first-hand, such information as they desired, and then in order to supplement the knowledge gained from these visits, talks and explanations were delivered in the classroom. Eventually these talks were put in writing and a copy given to each of the students. Afterwards it was decided that they should be printed and accordingly were assembled in the present volume.

The free use of tables, drawings and diagrams is made in the book in order to increase its value as a reference guide. The book is written with the object of presenting the subject so that no prerequisites on the part of the reader will be required, and only a limited education is necessary as the language used is as simple as possible consistent with clearness. It will prove of most value to those connected with the steel business who are not technically educated and who are anxious to learn more about the salient facts connected with the wonderful industry.

FUEL OIL IN INDUSTRY, by STEPHEN O. ANDROS, A. B., E. M., formerly Assistant Professor of Mining Research, Engineering Experiment Station, University of Illinois; author of *Coal Mining in Illinois* and *The Petroleum Handbook*. Price, $3.75; 274 pp., illustrated and indexed. Chicago: The Shaw Publishing Co.

THIS WORK constitutes a notable addition to the subject of fuel oil usage and contains many important tables and charts for calculation of fuel consumption. The earlier chapters are devoted to an elementary discussion of the physical and chemical properties of fuel oil including viscosity, flash points, calorific value, analysis of light, medium and heavy oils and ratios of air supply to chemical requirements.

An interesting and valuable discussion is given on a comparison of coal and fuel oil, while the last chapters are devoted to practical phases of the subject including "Distribution and Storage," "Heating and Pumping," "Types of Fuel Oil Burners" and a description of the use of fuel oil in the glass, steel, sugar, ceramic and a number of other industries.

The volume constitutes a very worthy attempt to furnish the reader with a general survey of the subject and contains specific information on a number of practical questions engaging the minds of fuel oil users.

SMITHSONIAN PHYSICAL TABLES, by FREDERICK E. FOWLE, Aid, Smithsonian Astrophysical Laboratory. (Publication No. 2539) Seventh revised edition, 1920. Washington: The Smithsonian Institution.

PHYSICISTS will find the present volume of very great reference value as will engineers in search of certain readily accessible data not always easily found elsewhere. We are glad indeed to have a copy for our own reference library. The work of Mr. Fowle and his assistants has entailed a considerable enlargement of the seventh edition. Older tables have been rectified with new data, and there are additions of some 170 entirely new tables. The scope has been broadened to include tables on astrophysics, meteorology, geochemistry, atomic and molecular data, colloids and photography. This has the effect of making it practically a new book.

Valuable criticisms, suggestions and data have been received for incorporation in this issue from the United States Bureau of Standards, including the revision of the magnetic, mechanical, and X-ray tables, from the Coast and Geodetic Survey (magnetic data), from the Naval Observatory, the Geophysical Laboratory and the Department of Terrestrial Magnetism; and also from Messrs. Adams of the Mount Wilson Observatory, Wilson of the Geophysical Laboratory (compressibility tables) Anderson (mechanical tables) Dellinger, Hackh, Humphreys, Mees and Lovejoy of the Eastman Kodak Co. (photographic data), Miller (acoustical data), Van Orstrand, Russell of Princeton (astronomical tables), Saun-

ders, Wherry and Lassen (crystal indices of refraction), White, Worthing and Forsythe and others of the Nela Research Laboratory, Zahm (aeronautical tables).

MAC'S DIRECTORY OF COAL SALES COMPANIES, 1921 Edition, 9x12, 132 pp, $2.00. Pittsburgh, Pa.: Coal Information Bureau.

REPRODUCTION of the first edition of this directory is due to first hand knowledge of the many benefits to be derived in the compilation of the information given by both the seller and buyer of coal. The data given in this publication was obtained from independent sources after months of arduous labor and at a large expense, and is as correct as possible to obtain at this time.

The publishers are practical coal men actively engaged in the producing and selling of coal. Among the contents are the lists of coal companies alphabetically arranged by states under cities located therein, giving, where possible to obtain, the names of companies, addresses, telephone numbers and names of principal officers. Notation is also made showing whether main or branch office and classification as to whether sales agent, operator, or wholesaler.

MODERN ROAD BUILDING AND MAINTENANCE, by ANDREW P. ANDERSON, Highway Engineer, Bureau of Public Roads, U. S. Dept. of Agriculture. Illustrated and Indexed, 146 pp. Chicago: The Hercules Powder Co.

DIFFICULT INDEED are the problems of the modern highway engineer, and the welfare and comfort of the entire community depend upon their successful solution. During the past fifteen years the efforts of highway engineers and road builders have been almost entirely devoted to devising ways and means to overcome the ravages of the ever-increasing automobile traffic. Each succeeding year has seen substantial progress in these efforts, and a practical solution of nearly all the attendant problems seemed almost within reach. Then came the heavy motor truck. Under this new traffic the improvements, found sufficient and well adapted to care for the horse-drawn vehicle and the automobile, almost invariably deteriorate and sometimes fail entirely.

Present road and traffic conditions call most insistently for a more scientific application and more rational interpretation of the practical experience of the past, as well as the present. This is impossible without a clear understanding of the fundamental principles involved, principles which unfortunately are not always so apparent even to the scientist as the novice would have us believe. The blind copying of rules and methods and the mere following of precedents can never be successfully substituted for correct reasoning from established principles and the scientific interpretation of experience.

This book is therefore devoted to setting forth the basic principles underlying road building and maintenance and calling attention to the meaning of the more important results of present-day experience rather than to any extended review of present practice.

We acknowledge receipt of the *Alamexa Bulletin,* published every Saturday by the All America Export Association, Inc., of the District National Bank Building, Washington. This bulletin is part of a service for sales promotion in Latin American countries and in Spain and is obviously of great value to corporations and individuals engaged in business in the Hispanic countries. We learn that the new association and its work are successfully conducted on new and practical lines. The weekly publication, in red, white and blue, is a credit to the organization.

The U. S. Bureau of Mines has recently issued Bulletin 205 entitled Flotation Tests of Idaho Ores by Clarence A. Wright, James G. Parmelee and James T. Norton, which was prepared in coöperation with the School of Mines, University of Idaho, and the Idaho Bureau of Mines and Geology. This paper deals with the possibilities of differential flotation treatment of lead zinc ores of the Coeur d'Alene region, and in particular manner to the results obtained on the relatively fine material and slime produced in the mill. It is well illustrated and the numerous tabulated tests reported will be found of considerable value.

An attractive booklet was recently issued by the Baldwin Locomotive Works, Philadelphia, Pa., giving a description of the Walschaerts Valve Gear which has come into extensive use in American locomotive practice since 1905. Its principal advantage lies in the accessibility of its parts which are placed entirely outside the driving wheels and because of this it facilitates oiling, inspection and cleaning operations. Many of the other advantages of this type of gear are shown with illustrations. The booklet gives a clear and concise presentation of this mechanical device which will be found of considerable value to those having to supervise the operation of locomotives.

AIRPLANE RADIO SERVICE

EXPERIMENTS conducted jointly by the Post Office Department and the Bureau of Standards have determined that radio signaling for airplanes is practical and an aid to navigation provided that certain precautions are taken, such as making the radio apparatus sufficiently rigid to stand severe vibration and the use of a special type of antenna located in the fuselage of the machine as far as possible from the engine and the wires of the ignition system. Metal sheaths must be provided to protect the radio receiving apparatus from the ignition system, though the disturbances from this cause can be reduced by the use of a compensating coil in the receiving apparatus.

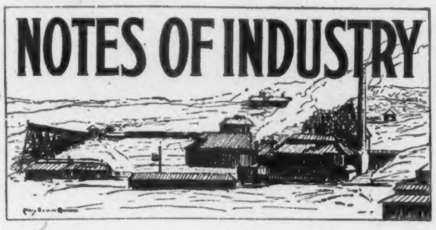
The use of a coil type of antenna or radio compass makes it possible not only to carry on communication but also to guide the airplane and determine its position by radio methods. By the use of special transmitting apparatus located on the landing field, the airplane is able to determine its position with respect to the field and to descend safely in darkness or fog. Two methods have been found practicable for such signaling apparatus; the use of alternating current of relative low frequency in a large coil on the landing field, and the use of radio signals transmitted from a special type of antenna on the landing field.

DIFFUSION OF GASES

Diffusion of gases may be defined as the gradual mixing of two or more gases which are in contact, according to A. C. Callen in Bulletin 39 of the Fed. Bd. of Voc. Ed. This mixing is not dependent on the specific gravity of the gases, for if we fill a jar with a heavy gas like CO_2 and another jar with a light gas like N and then bring the mouths of the jars together, the jar containing the N being on top, we shall find that in a comparatively short time the two gases have become thoroughly mixed and the composition of the gas in each jar will be exactly the same; that is, 50 per cent. CO_2 and 50 per cent. N. After gases have become mixed by diffusion they will not again separate. This property of diffusion is what makes possible the efficient removal of gases from mines. If, for example, methane, which is only about half as heavy as air, would always stay at the roof and not become mixed with and swept away by the air current we would have a dangerous condition continually present.

It is estimated that American newspaper advertising amounted to $200,000,000 in 1920 as against $150,000,000 in 1919.

AN ATTRACTIVE NEW BUSINESS FOR AIR COMPRESSOR SALESMEN



Blakmetal, the Italian war alloy, is claimed to have greater strength than steel or any other metal, with a higher limit of elasticity. It is an alloy of zinc and copper, endures a high temperature, and resists corrosion better than copper. Its lightness, great strength and non-corrosiveness have fitted it especially for aeroplane and ship construction. Though stated to be not yet fully developed, its varieties offer advantages in working as substitutes for steel, brass and aluminum. It can be cast, turned, drawn, forged, rolled, and stamped.

Alaska shipped $34,781,970 worth of canned salmon to the United States in 1920, which amounted to 194,670,530 pounds.

How one thing leads to another is proverbial, but they do not always immediately follow each other. The Bureau of Standards has developed a compass which indicates the direction from which radio signals come, and this is a being put to immediate practical use in the installation by the Lighthouse Service of three wireless pay signal stations near the entrance to New York Harbor. Signals emanating from these stations may be picked up on shipboard and by taking their bearings the position of the vessel is at once indicated and it may proceed with confidence.

A contract for a 1500 foot tunnel was let recently by the Eagle Bird Mining Co., South Dakota, to a miner in Trojan who expects to start work immediately. An Ingersoll-Rand double-stage air compressor was recently installed at the mine, and this in connection with 75 h. p. General Electric motor will furnish the power. Mr. Fred Pennington is president of the company, and Mr. Burt Rogers is secretary and treasurer. Mr. Pennington states that the ore bodies are in a vertical formation which are being cross-cut at depth of between five and six hundred feet, the same as found in the famous Cripple Creek, Colorado, country, containing a large amount of sylvanite as well as low grade ore.

The guards on either end of the ferry boats at San Diego, Cal., are operated by compressed air.

Some experiments which were carried out in Germany during the war showed the beneficial effects of blast-furnace gas on the growth and productivity of plants, due undoubtedly to the presence of carbon dioxide. Three adjacent greenhouses were noted particularly. Through the centre one ran two long pipes from which the waste gas was discharged at intervals; the two outer greenhouses, growing the same plants, were used by way of comparison. Apparently, within a few days the effect of the gas was visible in increased growth. The experiment was repeated on plants in the open air with the same success, those exposed to the gas yielding from one and a-half to three times as much as those not treated.

Approximately 350,000,000 tons of farm products were hauled to market in 1920 in motor trucks by farmers and gardeners in the United States at one-half the operating cost of horse-drawn transportation.

The following is the annual tonnage record of the Panama Canal: 1915—4,894,134; 1916—4,838,496; 1917—7,427,680; 1918—7,294,502; 1919—7,468,167; 1920—11,236,119.

In some of the latest power-houses in Germany the disposal of the ashes, etc., is carried out by two different devices. The flue ashes are withdrawn by the pneumatic plant—but the larger clinkers which collect at the back of the furnaces are raked from time to time into open channels, and flushed by water currents to the foot of a bucket elevator, by which they are raised to overhead bunkers, to be loaded by gravity into railway trucks.

Attempting to quench a fire that had started from a short circuit, Abe Ericson, a miner employed at the Big Cottonwood mines near Salt Lake, grabbed a metal bucket containing water and pitched the contents upon the blaze. The current, following the path of least resistance, backed into the stream of water, bucket, and then through the unfortunate man, killing him instantly.

FOREIGN TRADE OF AUSTRIA

The Board of Trade publishes the statistical figures covering Austria's foreign trade for the second half of 1920. The imports amounted to about 10,000 tons of goods and the exports 2500 tons. But whilst the imports consisted principally of food stuffs, coal and raw materials for the industries, the exports showed high grade industrial products. This goes to prove that Austria's industries, if properly managed, still may constitute a "going concern." In spite of the friction and jealousies of Czecho-Slovakia towards Austria the old ties prove so mighty that the commerce with this country ranks in the first place. Then comes the trade with Jugoslavia. The conditions in Hungaria are still too much unsettled to allow of any important business intercourse. The trade with Poland has been humming, Austria exporting much machinery to this country in exchange for coal chiefly. Austria now imports most of her necessaries from Germany, compressing a third of her total imports. Exports to Germany have been only 500 tons of goods. Trade with the other countries has been negligible. The principal items of Austrian exports have been paper, leather, leather goods, machines, furniture and electrical equipment. The automobile industry exported in the second half of 1919 some 11,768 cars.

The Noew Howard Coal Co. of Matewan has appointed Mr. Fred W. Schoew of Huntington, secretary and general manager.

* * *

Mr. E. E. Campbell has accepted the position of general superintendent for the United Verde Extension Mining Co., Ltd., Jerome, Ariz. Mr. Campbell has been with the Granby Co. at Anyox, B. C., for several years.

* * *

Mr. W. A. Carlyle of Attawa has left for London, England, where he will open offices as consulting mining engineer.

* * *

Mr. I. G. Wheaton, formerly superintendent for the Watchman Mining and Milling Co., Ltd., at Dryden, Ontario, has accepted a position with the Consolidated Asbestos, Ltd., of Thetford Mines, Quebec.

* * *

J. T. Donald & Co., Ltd., consulting analytical chemists and assayers, have engaged the services of Mr. J. R. Donald who has been chemical engineer for the Canadian Packing Co., Ltd., at Toronto, for several years.

* * *

Mr. Ralph T. Hirsh has returned to Alaska after a five months' trip to Panama.

* * *

Mr. Charles Stead of Eveleth, Minn., died in Chicago recently. Mr. Stead was mining captain of the Oliver Iron Mining Co. in the Eveleth district of the Mesabi Range for 25 years. He was born in Sweden in 1863 and came to the United States when he was 23 years of age.

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Mr. H. W. Dearing formerly promotion manager of the McGraw-Hill Company, Inc., New York, is now with the Walter B. Snow & Staff, Boston.

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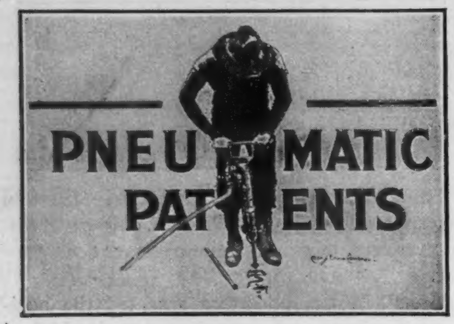
Mr. S. N. Clarkson, western editor of *Electrical World*, has resigned to establish the Clarkson Specialty Company, distributors of electrical specialties in St. Louis.

Russian trade representatives, according to the Whaley-Eaton Service, admit that they have no raw products to exchange for desired importations of goods, but they expect to make payment in concessions. The much-discussed Vanderlip affair was intended as a notice to the world of this policy. Credits will also be sought on the ground that ample raw material will be available for export as soon as necessary agricultural machinery and other equipment have been imported.

The world's greatest market for leaf tobacco was in 1920 when 62,000,000 pounds were sold at Wilson, N. C.; 33,000,000 pounds were sold in 1919, the average price being $21.68 per 100 pounds against $48.94 per 100 pounds in 1919.



MARCH 15

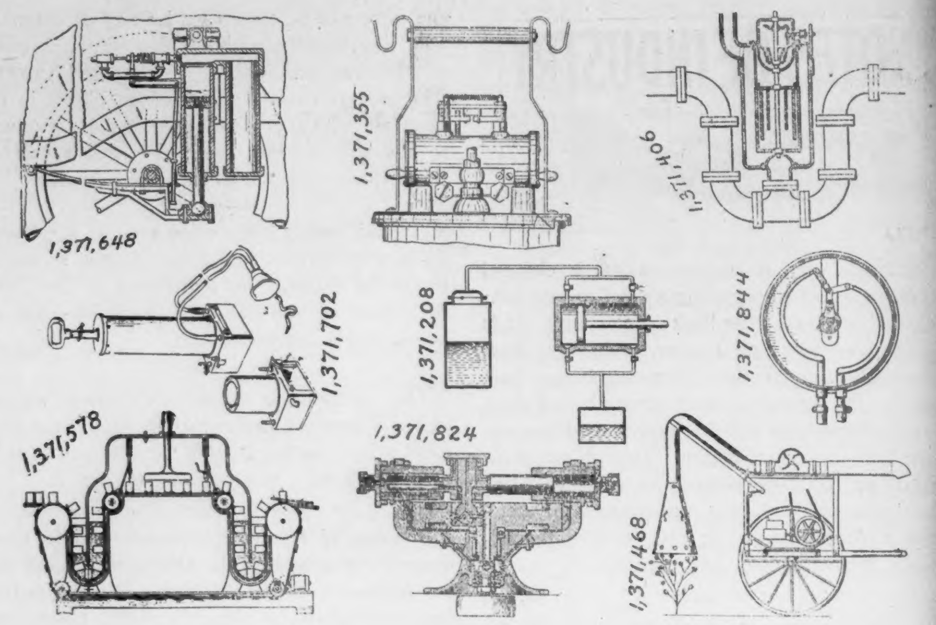
1,371,268. CRACKING OILS. Walter O. Snelling, Pittsburgh, Pa.
1,371,355. MILKING APPARATUS. Laurits Dinesen, Minneapolis, Minn.
1,371,406. SEWAGE-PURIFIER. John P. Ball, Chicago, Ill.
1,371,412. PORTABLE SPRAYING-MACHINE. John S. Davis, Seattle, Wash.
1,371,444. CONTROL FOR AIR-DELIVERY COOLER FOR TURBO-COMPRESSORS. Earl H. Sherbondy, Cleveland, Ohio.
1,371,468. COTTON-PICKING MACHINE. Austin E. Burgess, Jacksonville, Tex.
1,371,578. VACUUM CAN-SEALING MACHINE. Laurence O. Schopp, Chicago, Ill.
1,371,648. PNEUMATIC SPRING-SUPPORT FOR MOTOR-VEHICLES. Frank Schmidt, Tucson, Ariz.
1,371,702. RESPIRATING DEVICE. Edward H. Lyon, Cleveland, Ohio.
1,371,721. EXHAUST-VALVE FOR HAMMER-DRILLS. Lewis C. Bayles, Easton, Pa.
1,371,824. AIR-COMPRESSOR. Charles M. Tursky, New York, N. Y.
1. An air compressor including a cylinder having a discharge port and an air inlet passage, together with a piston operating in said cylinder and actuating means therefor, said piston having an air passage constantly open to the atmosphere and adapted to make and break communication with the air passage of the cylinder by the movements of the piston.
1,371,844. GAGE. Robert Gerry Bloxsom, Camden, N. J.

MARCH 22

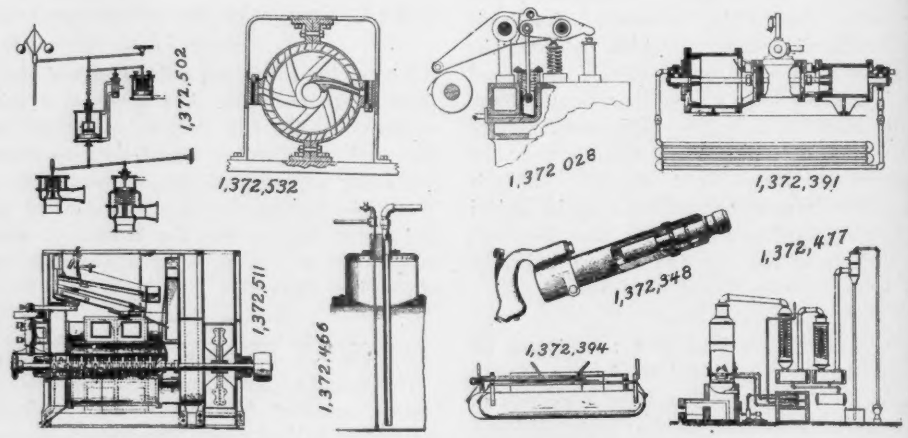
1,372,028. COMPRESSED-AIR STARTING DEVICE. Olav Eskil Jorgensen, Copenhagen, Denmark.
1,372,348. PNEUMATIC HAMMER. Charles H. Haeseler, Chicago, Ill.
1,372,391. FLUID-COMPRESSING APPARATUS. John S. Barner, Colver, Pa.
1,372,394. ADJUSTABLE DRY-DOCK. Adrien C. Beckert, Los Angeles, Cal.
1,372,466. LOADING MEANS FOR TANK-CARS. Andrew B. Whoolery, Spencer, W. Va.
1,372,477. DISTILLATION OF FATTY ACIDS. John W. Bodman, Western Springs, Ill.
1,372,532. AIR COMPRESSOR OR PUMP. Soren C. Monberg, Leadville, Colo.
1,372,502. REGULATION OF ROTARY COMPRESSORS. Willibald Grun, Frankfort-on-the-Main, Germany.
1,372,511. SCOURER. Charles T. Howson, Owensboro, Ky.

MARCH 29

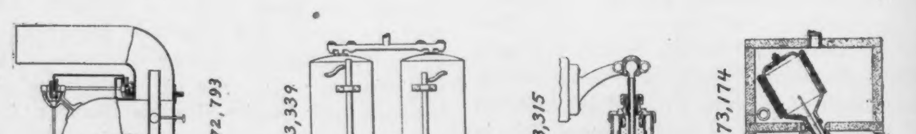
1,372,735. BLOWPIPE. George H. Zouck, Orange, N. J.
1,372,764. FLUID ACTUATING AND CONTROL ENGINE. Andrew D. Miller, Johnstown, Pa.
1,372,793. MEANS TO PROTECT VEGETATION FROM FROST. Gustaf Edwin Anderson, Erikshall, near Upsala, Sweden.
2. Means to protect vegetation from frost, comprising a laterally directed pipe, a fan supplying air and a boiler supplying steam to said pipe and a stove mounted in said boiler and discharging the products of combustion into said pipe, and means for swinging or oscillating the pipe around a vertical axis so as to spread the air.
1,372,798. METHOD AND APPARATUS FOR MEASURING GAS-PRESSURE. Oliver E. Buckley, East Orange, N. J.
1,372,931. PNEUMATIC PUMP FOR WATER SYSTEMS. John J. Brown, Alvinston, Ontario, Canada.
1,372,984. FLUID-CLUTCH. August Sundh, Hastings-upon-Hudson, N. Y.
1,372,994. PNEUMATIC PUMPING APPARATUS. Adam E. Chodzko, San Francisco, Cal.
1,373,068. PNEUMATIC-TIRE PUMP. John L. Harper, Seattle, Wash.
1,373,174. REFRIGERATING APPARATUS. Jay Grant De Remer, Washington, D. C.
1,373,175. COMPRESSOR. Jay Grant De Remer, San Francisco, Cal.
1,373,315. CUSHIONING DEVICE. Joseph F. Dunn, Providence, R. I.
1,373,318. POWDER-DISTRIBUTER. Daniel Gordon Edwards, Hopkinsville, Ky.
1,373,339. AIR-COMPRESSOR. John Patrick Loftus, Ogden, Alberta, Canada.



March 15



March 22



March 29